The Journal of Bone and Joint Surgery

The Official Publication of
The American Orthopaedic Association
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The American Academy of Orthopaedic Surgeons
The Australian Orthopaedic Association
The Canadian Orthopaedic Association
American Society for Surgery of the Hand
New Zealand Orthopaedic Association
South African Orthopaedic Association

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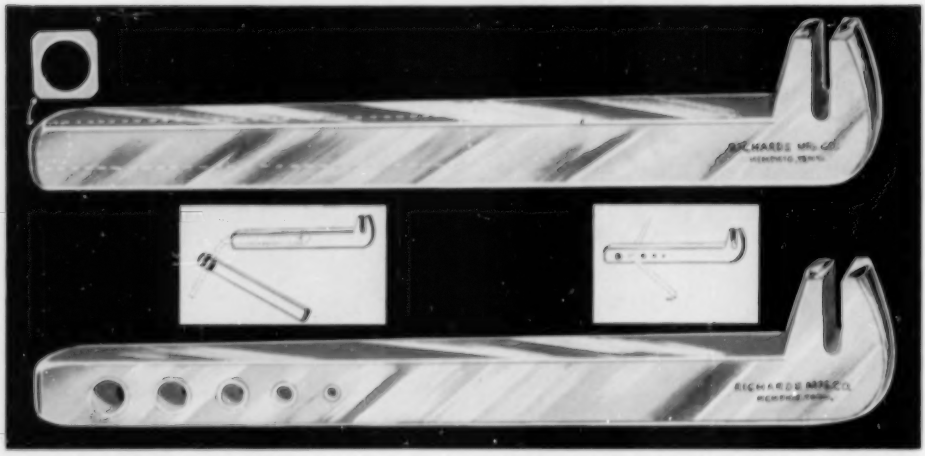

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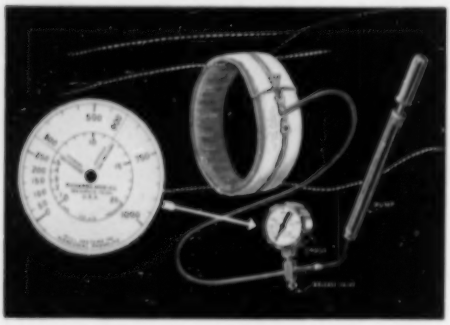

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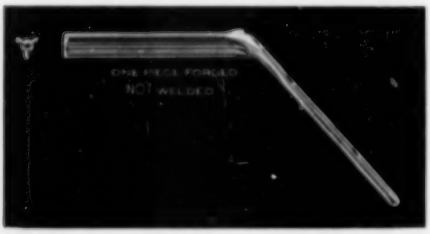

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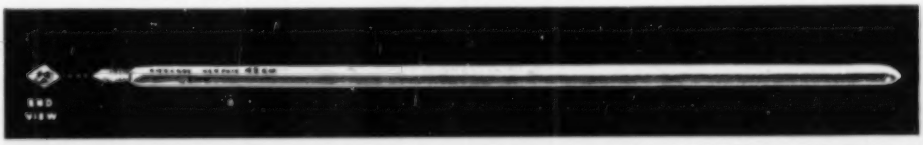

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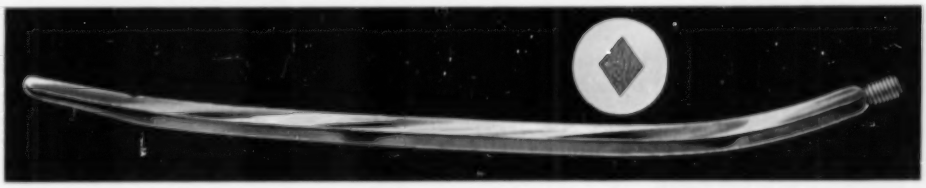

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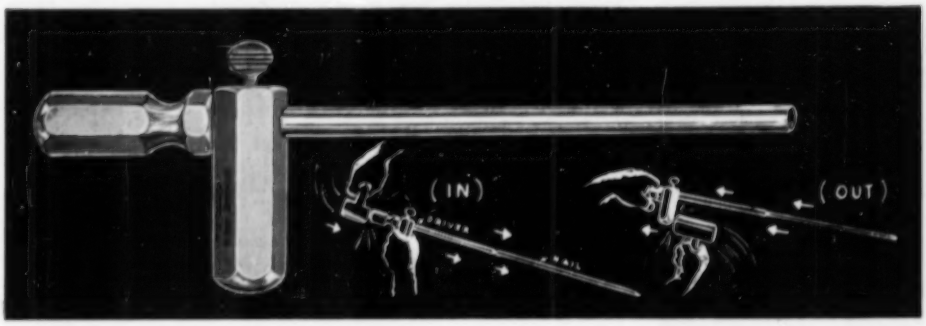

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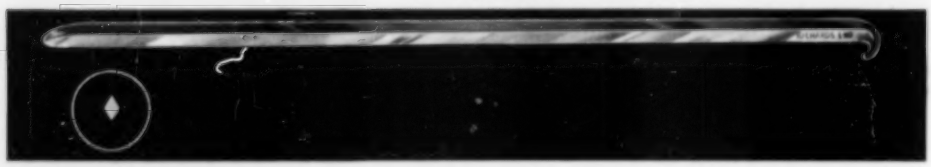

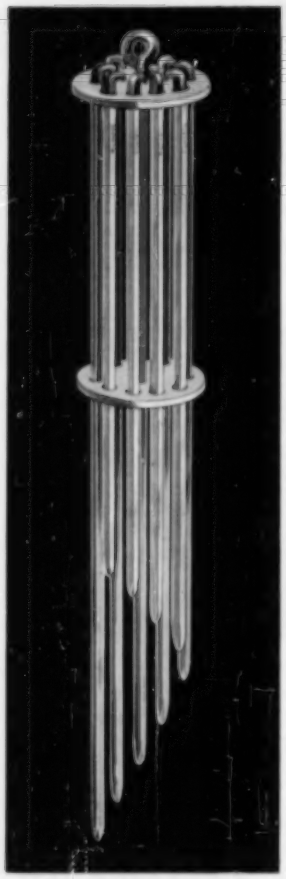

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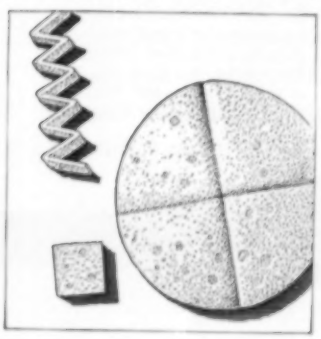

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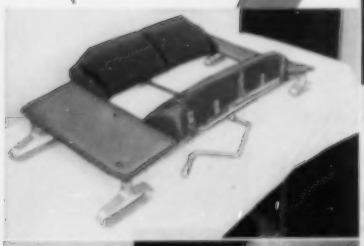

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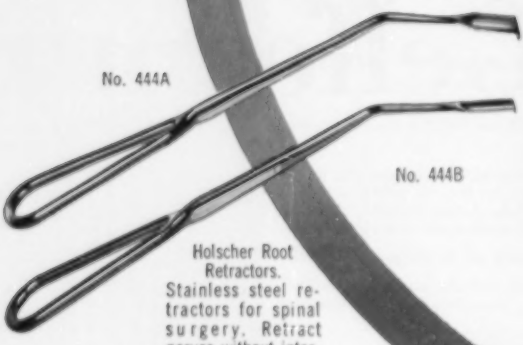

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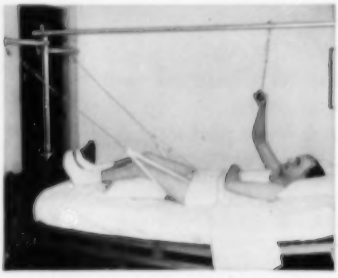

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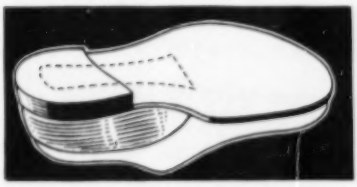

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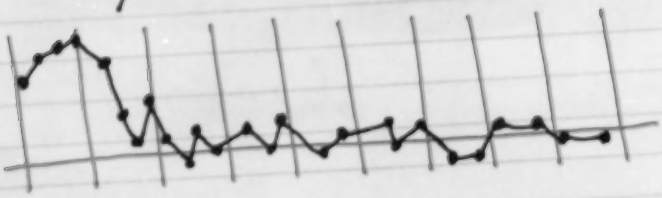
Dx/ Pneumonia



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brand of oxytetracycline

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When the diagnosis is pneumonia, Terramycin therapy usually brings quick results because this broad-spectrum antibiotic is equally effective against coccal, Friedländer's and atypical virus pneumonia.

"After the administration of Terramycin, 59 of the [60] patients...improved rapidly with almost complete defervescence within twenty-four hours."[1]

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"A case of staphylococcal pneumonia, complicated by tension pneumothorax which had shown no response to [another antibiotic], made a rapid, complete recovery on a dosage of 15 mg. per lb."[3]

1. Knight, V.: New York State J. Med. 50:2173 (Sept. 15) 1950.
2. Fotterfield, T. G., and Starkweather, G. A.: J. Philadelphia Gen. Hosp. 2:6 (Jan.) 1951.
3. Swift, P. N.: Proc. Roy. Soc. Med. 44:1066 (Dec.) 1951.

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Tremendously strong but weighs less.
No welding, riveting, or other foreign materials.

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a-b-c Support is Triple-Safe because the stress is carried by the three regions of the femur which normally support the weight: the calcar, the medial cortical column, and the strong lateral cortex.

Fits Any Size Patient because unique tube cutter cuts the stainless steel shaft to precise length right in surgery.

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The thermal and massage stimulus of this constantly agitated water is perhaps the most useful form of hydrotherapy in the after-care of amputation stumps, polio and in orthopedic cases.

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Here is the efficient and speedy cutter for cutting a window, bivalving, or removing a complete cast. Maximum convenience and safety is assured because the Stryker Cast Cutter cuts plaster by the unique principle of high-speed oscillation. No depth-gauges are required. You save precious minutes, and spare the patient needless pain and discomfort. Inquire today about these time-saving features.

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Orthopedic

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References: "Internal Contact Splint" —Eggers, G.W.N.
Jour. Bone & Joint Surg., 30-A, No. 1, Jan. 1948
"The Influence of The Contact-Compression Factor on Osteogenesis in Surgical Fractures" — Eggers, G.W.N., Shindler, T.O. and Pomerat, C.M.,
Jour. Bone & Joint Surg., 31-A, No. 4, Oct. 1949

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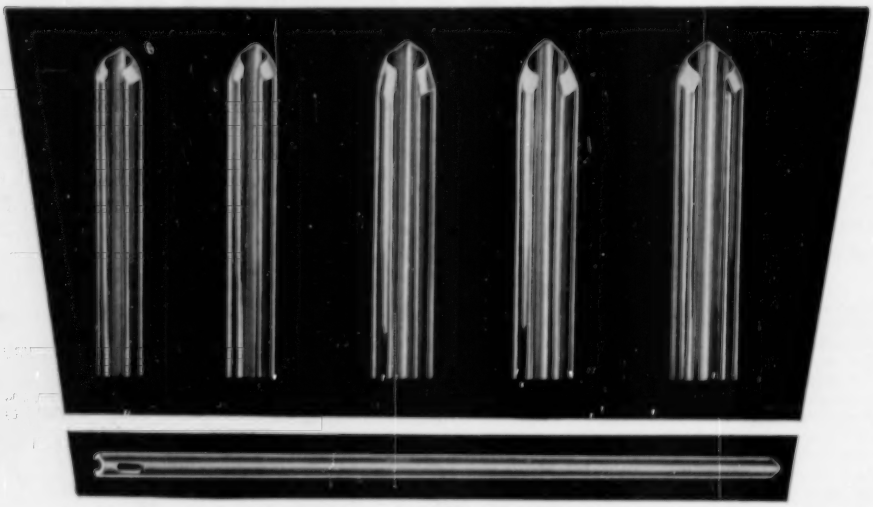

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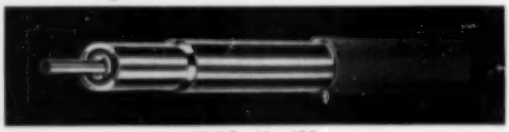
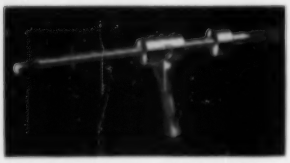


Nail Set No. 422

Medullary Nail Extractor



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As a result of cooperation with cineplastic research, HANGER has developed the "Cinematic" Arm, designed for application to patients with cineplasty operations. Principles of simplicity, durability, light weight, alignment, proper cosmetic appearance, and proper fitting of a comfortable socket have all been important considerations in the development of this new Cineplastic Prosthesis. In making the below-elbow prosthesis, utilizing a biceps motor, the socket and forearm shell are constructed over a plaster reproduction of the stump. A wrist coupling is fitted at the terminal end of the forearm shell.

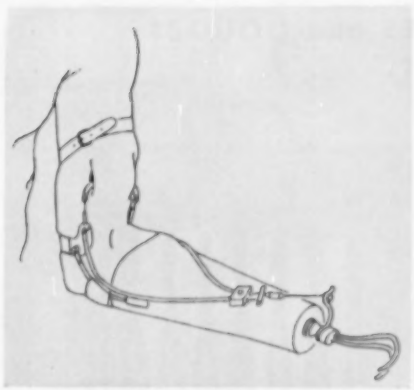

FIG. 1. Below-elbow cineplastic prosthesis with cables and terminal device fitted.

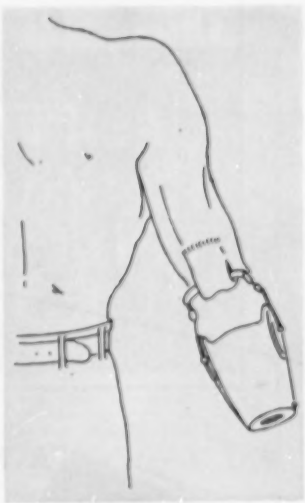

FIG. 2. Showing below-elbow prosthesis on stump with muscle tunnel pin in place.

Whatever your interest or problem in appliances suitable for cineplasty or any phase of arm prosthetics, we are anxious to cooperate in every way possible. Please contact our nearest representative at any time.

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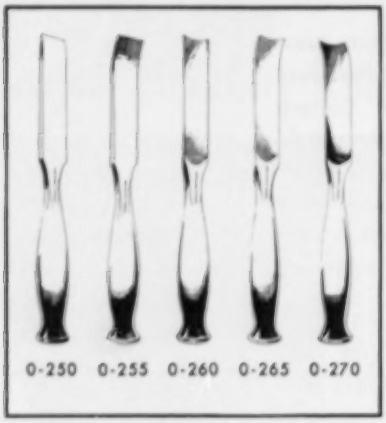

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0-250 SMITH-PETERSEN OSTEOTOME—straight, 8", sizes ¼", ⅜", ½", ⅝", ¾", 1" and 1¼". Stainless Steel.

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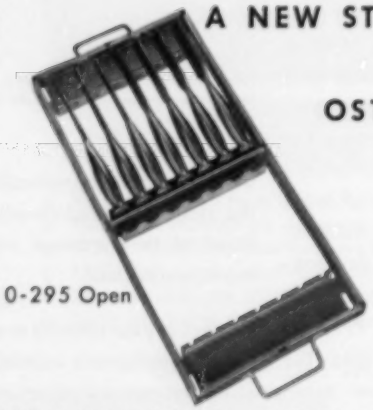

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CASE 0-295—holds seven Smith-Petersen Osteotomes.

CASE 0-296—holds seven Smith-Petersen Gouges.

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CREATES AMAZING CONFIDENCE AND RESULTS
PROVIDES 35 TO 40 DEGREE CIRCUMDUCTION
UNIVERSAL JOINT CRAB FOOT CAN NOT SLIP

UNIVERSAL JOINT CRAB FOOT CRUTCH

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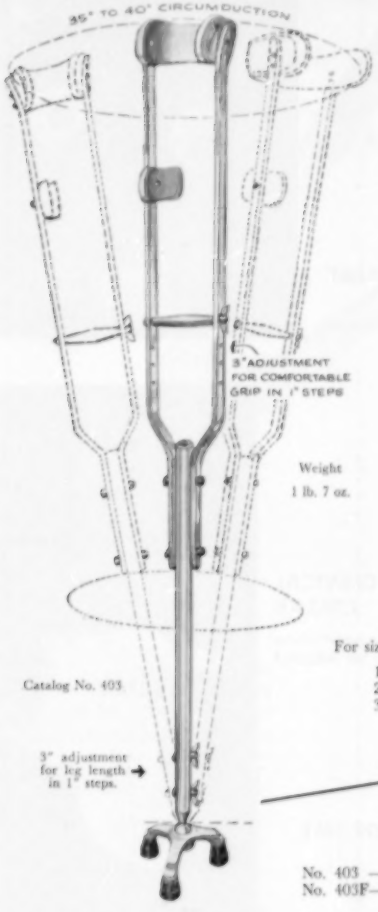
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3" ADJUSTMENT FOR COMFORTABLE GRIP IN 1" STEPS
Weight 1 lb. 7 oz.
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3" adjustment for leg length in 1" steps.

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Dr. Borden Bachynski, originally designed and recommends this modified crab or training crutch with universal joint as a mechanical aid in walking to patients requiring more than the average amount of stabilization provided by the ordinary single tip crutch. It eliminates unstable one point fixation and provides a stable tripod which tilts perpendicularly to any walking surface by virtue of its universal joint. This joint allows 35 to 40 degrees of circumduction and therefore compensates for any angular thrust put on the crutch. When the base is seated, gait is completed through this joint without disturbing the resting tripod.

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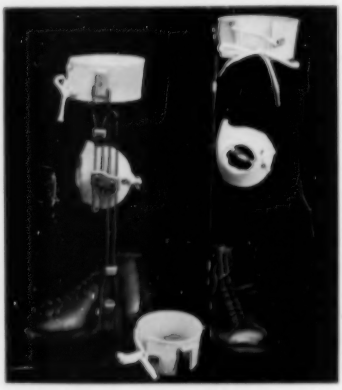

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CAT. No. 250-145

This new, streamlined Bone Pin Cutter adequately serves the needs of modern bone fixation—cuts all standard pins, nails or wire with unusual ease, safety and efficiency.

Shaped for easy insertion and manipulation in open wounds—chrome-plated to resist corrosion—this Sklar instrument is 15″ in length, and of long-handled construction for extra-strong leverage.

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- ***Maintains proper position and support***
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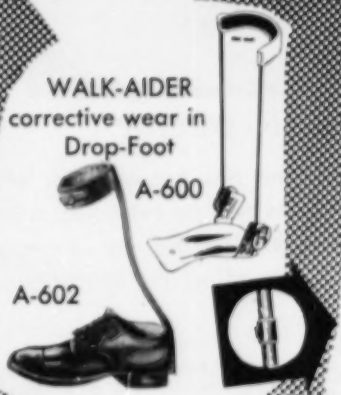

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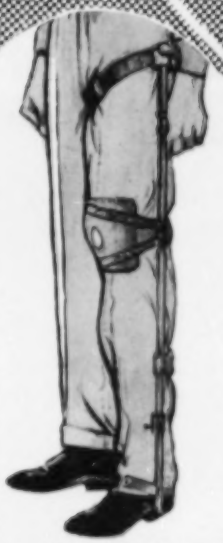

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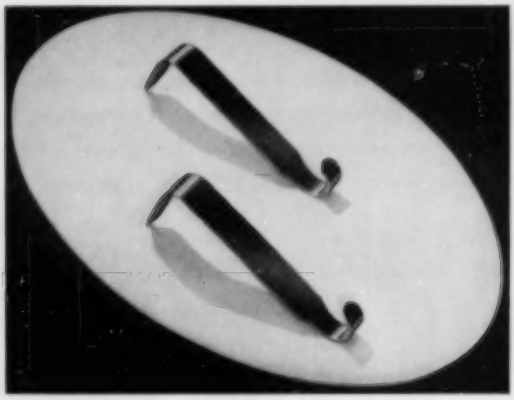

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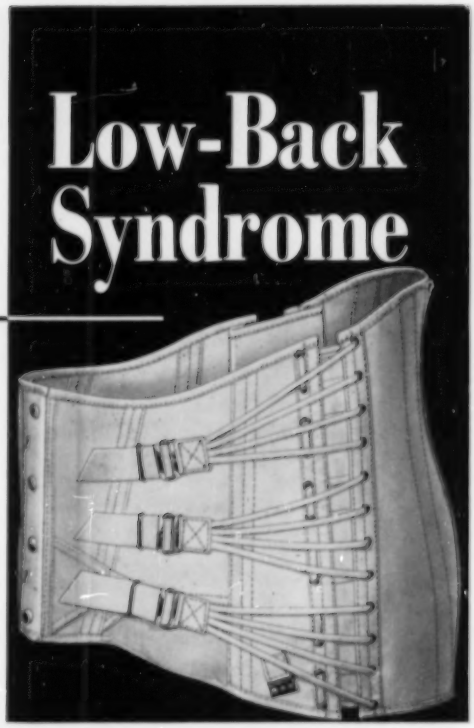

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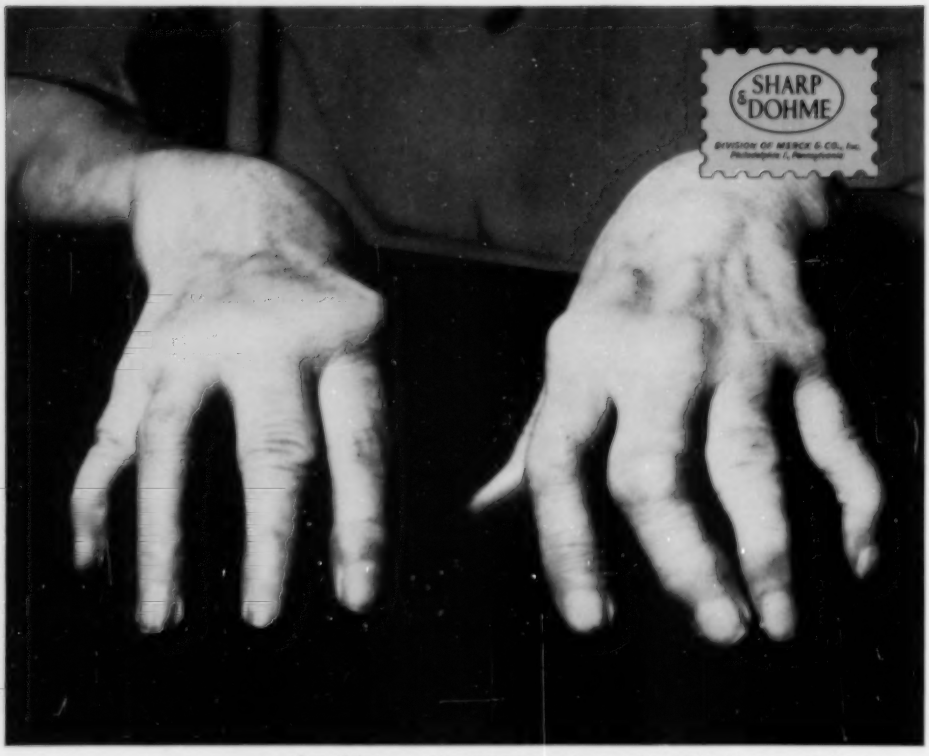

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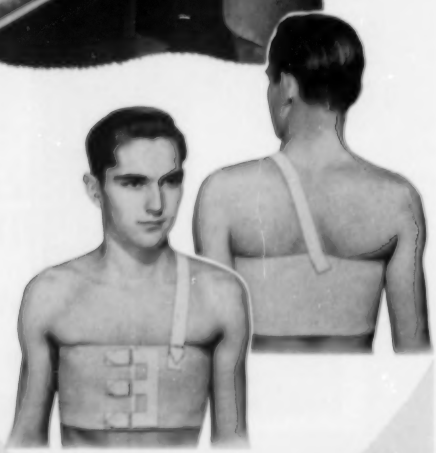

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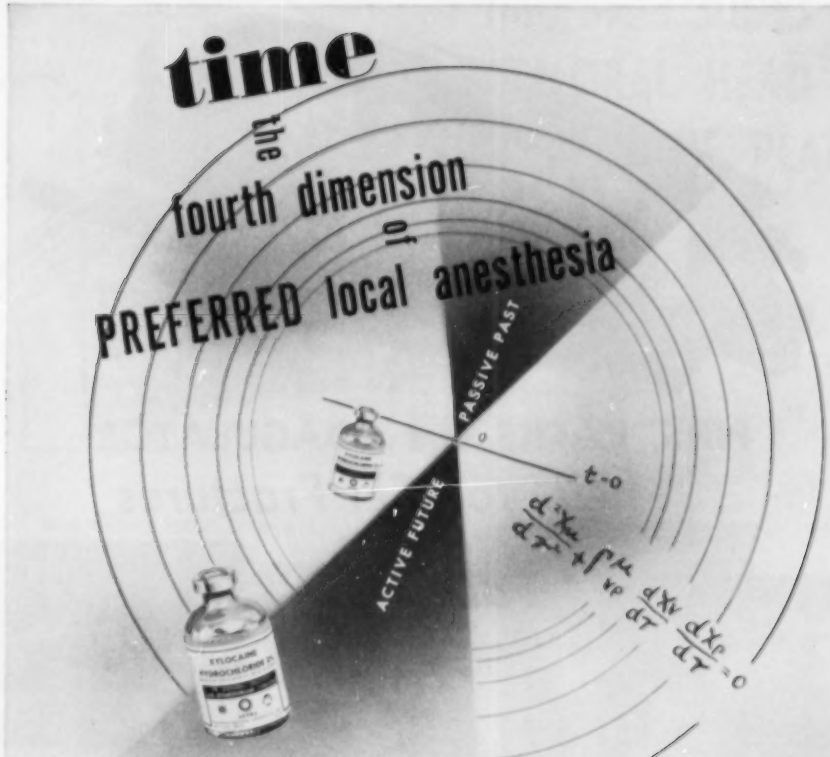

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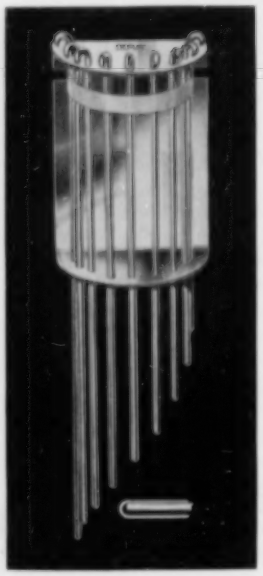

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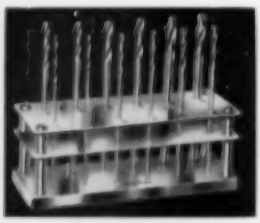

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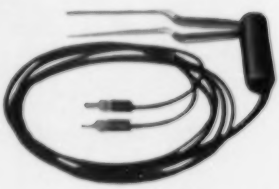

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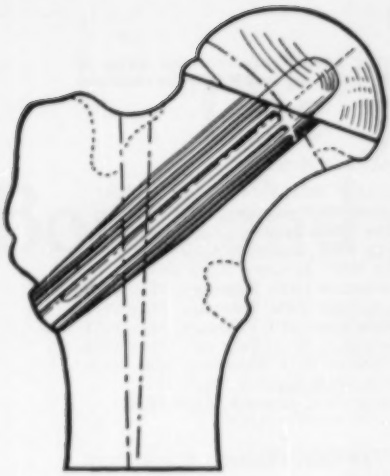

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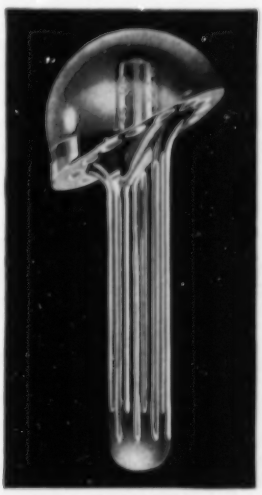

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VOL. 36-A, NO. 1 JANUARY 1954

The Journal of
Bone and Joint Surgery

American Volume

THE ANATOMY AND FUNCTION OF THE INTRINSIC MUSCULATURE OF THE FINGERS *

BY DON L. EYLER †, M.D., NASHVILLE, TENNESSEE,
AND JOSEPH E. MARKEE, PH.D., DURHAM, NORTH CAROLINA

Stimulated by the work of Duchenne, Bunnell, and others [1, 4, 5, 6, 7, 8], an investigation of the intrinsic mechanism of the hand was begun in 1949 in the Department of Anatomy at Duke University. This report deals with basic facts concerning the anatomy and function of the lumbrical and interosseus muscles of the hand. Material for this study was gained by cadaver dissection of over thirty hands, by experimental peripheral-nerve blocks in human beings, and *in vivo* experimentation in monkeys. The investigation is still in progress and other aspects of the study will be presented later. Nothing new or revolutionary is presented, and actually, most of the facts can be found in Dr. Bunnell's excellent text. A review, however, of the basic anatomy of the hand is important to surgeons who work daily with this finely coordinated mechanism, and it may be stimulating to others.

THE LUMBRICALES

A lumbrical muscle enjoys the singular distinction of having its origin on a flexor tendon and its insertion into an extensor (Fig. 1). Usually four in number, these cylindrical muscles arise from the profundus tendons and approach the radial aspect of the metacarpophalangeal joint volar to the transverse metacarpal ligament. They insert 100 per cent. into the lateral bands of the extensor aponeuroses, in most instances. In the monkey, the lumbricales uniformly find insertion into the base of the proximal phalanx as well as into the extensor aponeurosis. In over thirty human hands which were dissected, only nine lumbricales were found to have definite bony insertion — the fourth lumbrical most frequently. The third and fourth lumbricales are variable in their insertion and the third lumbrical is occasionally absent (Table I). It should be noted that the first and second lumbricales arise from single tendons and the third and fourth from adjacent tendons. The second lumbrical also occasionally arises from adjacent tendons. This, in part, contributes to the lack of individuality of function of the medial profundus. The third and fourth lumbrical muscles are bipennate in their most proximal portions.

A lumbrical muscle has an average fiber length of about fifty millimeters, which is longer than that of the interossei, and therefore it has a potentially greater excursion. In the average hand, the first and second lumbricales are supplied by the median nerve, and the third and fourth by the ulnar nerve. Many functions are credited to these unique muscles, among them being (1) initiation of flexion of the metacarpophalangeal joint, (2) extension of the interphalangeal joint, (3) definitive flexion of the metacarpopha-

* Read at the Annual Meeting of the American Society for Surgery of the Hand, Chicago, Illinois, January 23, 1953.
† Aided by a fellowship from the National Foundation for Infantile Paralysis, Incorporated, New York, N. Y.

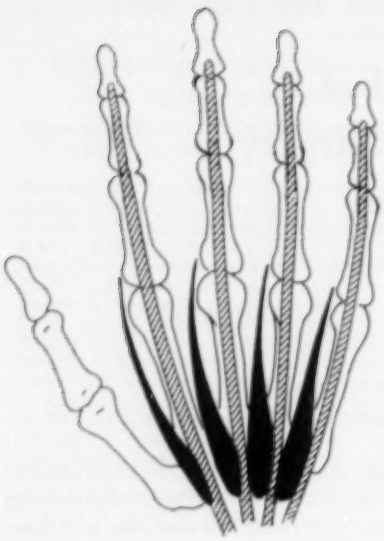

FIG. 1

Fig. 1: A schematic representation of the origins and insertions of the lumbrical muscles of the hand.

langeal joint, (4) radial deviation of the digits, and (5) the pulling of the profundi distally to allow the interphalangeal joints to be more easily extended. Considering each function in turn, we find that the lumbricales are in an ideal position to initiate flexion of the metacarpophalangeal joints, and this they do, although rather weakly. In clinical or experimental low ulnar-nerve paralysis, we note the ability of the lumbrical acting alone to stabilize the metacarpophalangeal joints of the index and middle fingers for the action of the extensor digitorum communis on the interphalangeal joints. In experimental high radial, ulnar-nerve block, and at the operating table, the first or second lumbrical acting alone is able to extend the interphalangeal joints, but not completely. Extension of the interphalangeal joints is incomplete, regardless of the tension placed upon the profundus tendon from which the lumbrical originates.

It can be demonstrated experimentally that the lumbricales do contribute to the power of extension of the interphalangeal joints. In the normal hand, the intrinsic muscles

TABLE I

PERCENTAGE OF INSERTION OF ONE HUNDRED AND TWENTY-EIGHT LUMBRICALES *

First Lumbrical	Hands dissected 33
Into radial side of index finger, exclusively	33
100 per cent.† into lateral expansion, exclusively	31
Small bony insertion	2
Second Lumbrical	Hands dissected 34
Into radial side of long finger, exclusively	34
100 per cent. into lateral expansion	34
Third Lumbrical	Hands dissected 32
Into radial side of ring finger, exclusively	25
Into ulnar side of long finger, exclusively	1
Bifid insertion (50 per cent. into radial side of ring finger, 50 per cent. into ulnar side of long finger)	5
Definite bony insertion	1
100 per cent. into lateral expansion	31
Fourth Lumbrical	Hands dissected 29
Into radial side of little finger, exclusively	25
100 per cent. into lateral expansion	19
100 per cent. into lateral expansion, ulnar side of ring finger, exclusively	2
Bifid insertion (50 per cent. into radial side of little finger, 50 per cent. into ulnar side of ring finger)	2
100 per cent. into bone of proximal phalanx	3
Part into bone and part into expansion	2

* Note that the third and fourth lumbricales are variable and that only the fourth lumbrical gains any significant bony insertion.

† 100 per cent. denotes the percentage of the total inserting fibers.

of the middle and ring fingers produce stronger extension of the interphalangeal joints than do the intrinsic muscles of the index and little fingers, and in that order. In high radial, low median-nerve block, it was possible to demonstrate considerable loss of power of extension of interphalangeal joints of the index and middle fingers, those fingers lacking lumbrical power. On repeated trials of extension, the index finger became tired first, next the long finger, then the little finger, and last, the ring finger. It is conceded that loss of proprioception in the index and long fingers might account for part of this loss of function.

Let us quickly review the basic components of a typical length-tension curve (Fig. 2). The finely dotted vertical line, labeled "resting length", represents the length at which a given muscle, when stimulated, will develop the greatest force of contraction. You

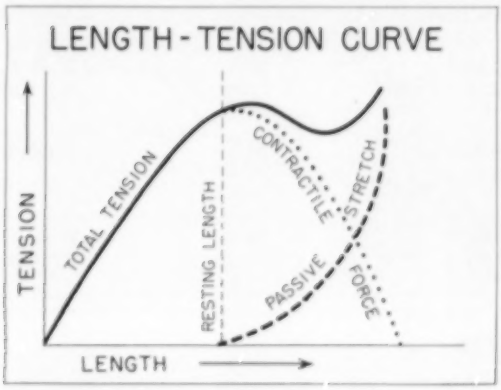

Fig. 2

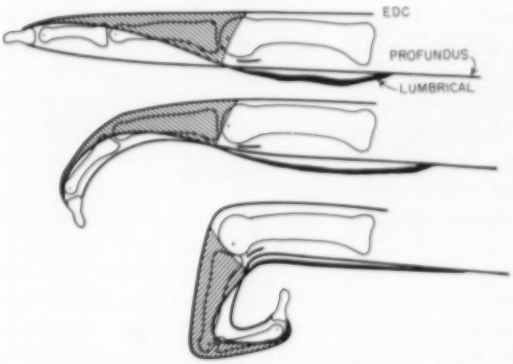

Fig. 3

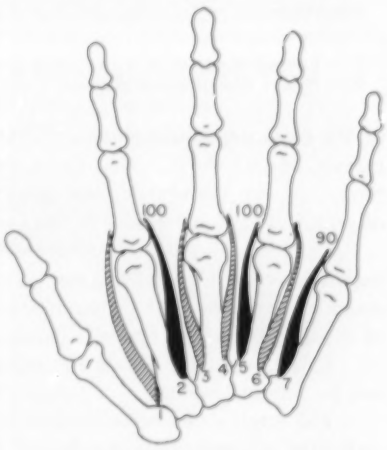

Fig. 4

Fig. 3: A schematic representation of the moving origins of the lumbrical muscle. As the tips of the fingers close in normal grasp, the tension on the lubricales is progressively increased.

Fig. 4: All primates except man have seven volar interossei. In man, the first, third, fourth, and sixth are anatomically part of the first, second, third, and fourth dorsal interossei, respectively. In this diagram, muscles two, five, and seven are the ones commonly referred to as volar interossei one, two, and three in man. The insertion represented here is approximate.

will note that the finely dotted contractile-force curve drops off as the resting length of the muscle is exceeded. The heavy dotted line, the passive-stretch curve, represents the total tension developed in a given muscle when it is simply placed under passive stretch but not stimulated. This curve rises sharply as the resting length is exceeded. The heavy black line, or total-tension curve, represents the total tension developed by a muscle during passive stretch and contraction. From this we see that the useful work performed by a muscle can be derived from both the active contraction and from the passive stretch.

With the aid of its profundus tendon, each lumbrical adds materially to the force of flexion of the metacarpophalangeal joint. As the tips of the fingers close in normal grasp, the tension on the lumbricales progressively increases (Fig. 3). When grasp is almost completed, the lumbricales are physiologically in position to contribute most to the flexion

TABLE II

PERCENTAGE OF INSERTION OF THE VOLAR INTEROSSEI IN THE AUTHORS' STUDY COMPARED TO THOSE IN THE RESULTS OF C. R. SALISBURY

	Eyler-Markee		Salisbury	
Muscle	Number Dissected	Percentage of Insertion	Number Dissected	Percentage of Insertion
First volar interosseus	34	E 98.9 B 1.1	28	E 98.8 B 1.2
Second volar interosseus	31	E 99.6 B .4	28	E 100.0
Third volar interosseus	33	E 94.2 B 5.8	28	E 89.1 B 10.9

E = Lateral expansion of the extensor aponeurosis.
B = Bone of the proximal phalanx.

of the metacarpophalangeal joints and to grasp. In experimental low median-nerve paralysis, despite the fact that the index and long fingers are normally stronger in power of flexion at the metacarpophalangeal joint than are the ring and little fingers, the loss of power of the lumbricales in the former renders them weaker than the latter.

The lumbrical function of drawing the profundus tendon distally can be demonstrated experimentally both in man and in monkey. This function seems insignificant when one considers the fact that in low median-nerve paralysis, extension of the distal phalanges of the index and long fingers is completed without difficulty.

Experimentally, significant radial deviation of the digits by the lumbricales could not be demonstrated.

The lumbricales certainly join forces with the interossei in performing the finely coordinated movements of the fingers in such action as needle-threading. From our investigation, it would appear that their most important functions are to stabilize the metacarpophalangeal joint and to contribute to the force of the final phase of grasp. It is felt that the importance of the lumbricales is overrated, and that carefully controlled ob-

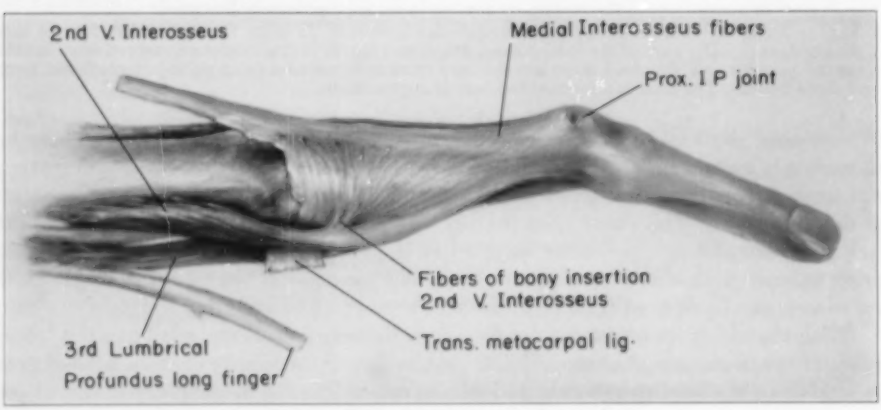

FIG. 5-A

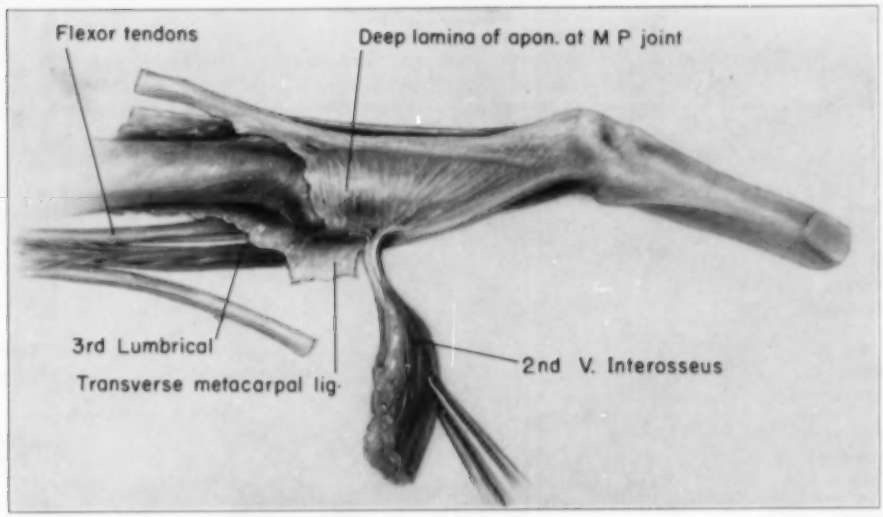

FIG. 5-B

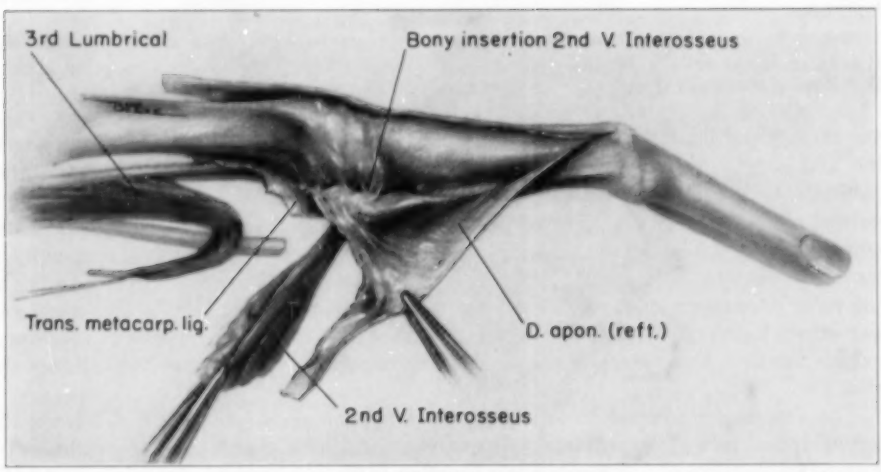

FIG. 5-C

Figs. 5-A, 5-B, and 5-C: The volar interossei insert primarily into the lateral bands of the extensor aponeuroses with minor insertion into the bases of the proximal phalanges. This series of drawings represents the only second volar interosseus to find bony insertion in over thirty human hands dissected.

servations, made before and after division of a nerve to a lumbrical and before and after division of a lumbrical itself, in the human hand, will lend support to this hypothesis.

THE VOLAR INTEROSSEI

All primates, except man, have seven volar interosseus muscles (Fig. 4). In man, the first, third, fourth, and sixth volar interossei are anatomically part of the first, second, third, and fourth dorsal interossei, respectively. The second, fifth, and seventh interossei are those commonly referred to as volar interossei one, two, and three in the human hand. Each volar interosseus is roughly fusiform in shape, has about twice the muscle mass of a lumbrical, and about half the muscle mass of a dorsal interosseus. This muscle originates primarily from a site near the base of the metacarpal of the ray it serves, and from the adjacent carpal ligaments. Its tendon courses dorsal to the trans-

TABLE III

PERCENTAGE OF INSERTION OF THE DORSAL INTEROSSEI IN THE AUTHORS' STUDY COMPARED TO THOSE IN THE RESULTS OF C. R. SALISBURY

	Eyler-Markee			Salisbury	
Muscle	Number Dissected	Percentage of Insertion		Number Dissected	Percentage of Insertion
First dorsal interosseus	34	E 1.6 B 98.4	(all to transverse fibers)	28	B 100.0
Second dorsal interosseus	32	E 31.4 B 68.6		28	E 48.4 B 51.6
Third doral interosseus	32	E 94.4 B 5.6		28	E 93.0 B 7.0
Fourth dorsal interosseus	28	E 56.9 B 43.1		28	E 66.6 B 33.3

E = Lateral expansion of the extensor aponeurosis.
B = Bone of the proximal phalanx.

verse metacarpal ligament, well below the axis of rotation of the metacarpophalangeal joint, and inserts primarily into the lateral band of the extensor aponeurosis with minor insertion into the capsule of the metacarpophalangeal joint, and into the base of the proximal phalanx of the digit (Figs. 5-A, 5-B, and 5-C). The average fiber length is about twenty-five millimeters, and nerve supply is normally from the ulnar nerve, although the lateral interossei are occasionally supplied by branches from the median nerve. Only the third volar interosseus gains any significant bony insertion (Table II). As Duchenne and many others have pointed out, this explains the fact that in any progressive type of lunar paralysis the first demonstrable weakness in the hand is the loss of power to adduct the digits.

The volar interossei act to flex the metacarpophalangeal joints, and to extend the interphalangeal joints; when the metacarpophalangeal joint is stabilized in extension by the extensor digitorum communis, their function is to adduct the index, ring, and little

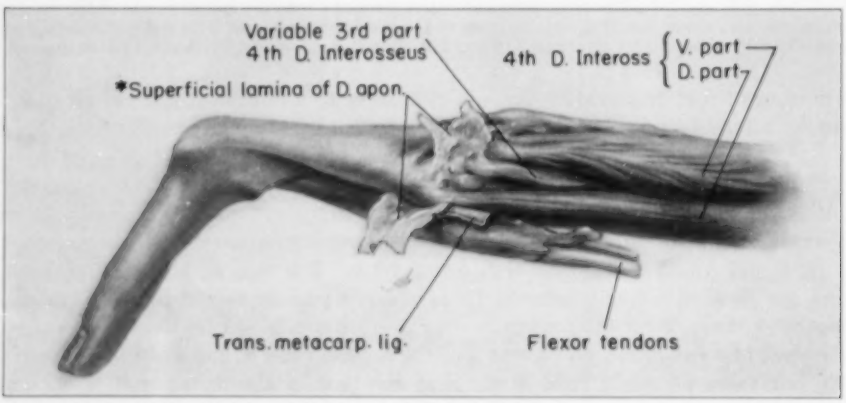

FIG. 6-A

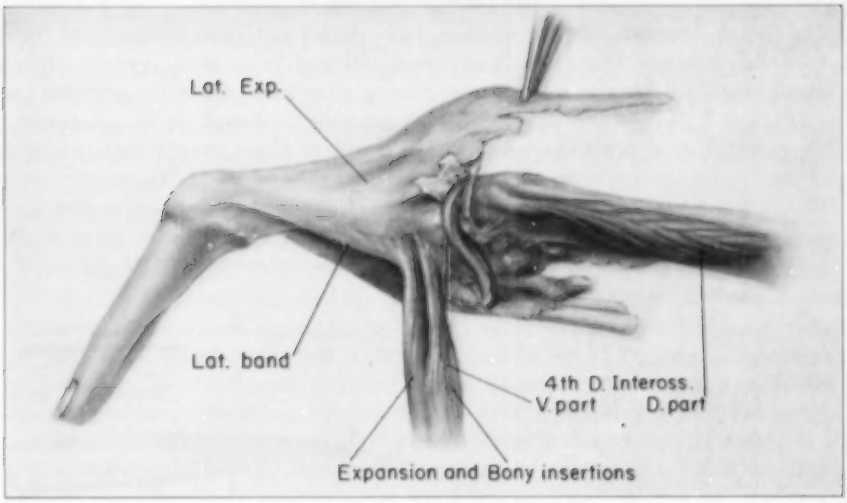

FIG. 6-B

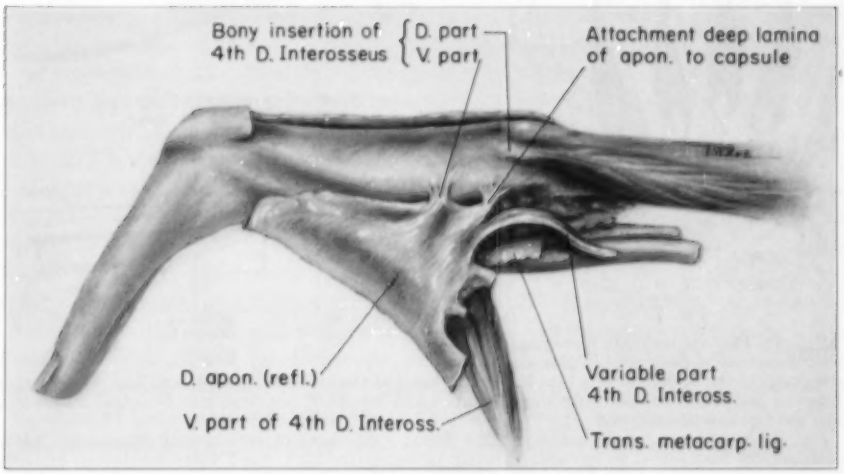
Bony insertion of 4th D. Interosseus
D. part
V. part
Attachment deep lamina of apon. to capsule
D. apon. (refl.)
V. part of 4th D. Inteross.
Variable part 4th D. Inteross.
Trans. metacarp. lig.

FIG. 6-C

Figs. 6-A, 6-B, and 6-C: A drawing of a fourth dorsal interosseus clearly showing the separation between the dorsal and volar components. Phylogenetically, the volar component is a volar interosseus muscle. By means of microdissection, one can often demonstrate separate nerve fibers to each component.

fingers. In contrast to the lumbricales, which only weakly extend the interphalangeal joints and rapidly lose their effectiveness as the metacarpophalangeal joint flexes, the volar interossei acting alone are able to extend completely the interphalangeal joints of the digit in all positions of the wrist and metacarpophalangeal joint except one, that being with the wrist fully extended and the metacarpophalangeal joint fully flexed. This, in part, can be explained by the angle at which the tendon of the volar interosseus inserts into the lateral band of the extensor aponeurosis and by virtue of the fact that the tendon passes dorsal to the pulley-like transverse metacarpal ligament. These conclusions were drawn from observations made on the first volar interosseus after high radial-nerve, high median-peripheral-nerve block.

THE DORSAL INTEROSSEI

The dorsal interossei, four in number, have dorsal and volar components. In most instances the separation is not clearly apparent, although in its most atavistic expression the fourth dorsal interosseus may present two or even three distinctly separate muscle bellies (Figs. 6-A, 6-B, and 6-C). The dorsal component of each dorsal interosseus, bipennate in structure and with an average fiber length of about twenty millimeters, originates from the contiguous sides of two metacarpals. This portion of the muscle occupies roughly the dorsal half of each interosseous space. Its tendon passes almost directly over the axis of rotation of the metacarpophalangeal joint, beneath the deep layer of the extensor aponeurosis, and except for the third dorsal interosseus, inserts primarily into

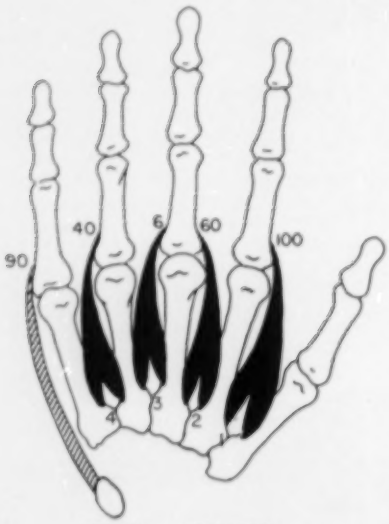

FIG. 7

Fig. 7: The approximate percentage of bony insertion of the dorsal interossei. The remainder of the muscle inserts into the lateral band of the extensor aponeurosis. The muscle arising from the pisiform is the abductor digiti quinti which inserts 90 per cent. into bone and 10 per cent. into the extensor aponeurosis.

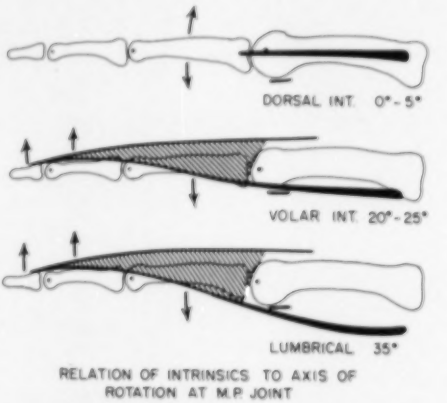

FIG. 8

Fig. 8: A schematic representation. The dorsal component of each dorsal interosseus (top) is anatomically best suited to forcefully deviate its respective digit. Each volar interosseus and volar component of each dorsal interosseus (middle) is in position to exert greatest force on the lateral bands of the extensor aponeuroses, to forcibly flex the metacarpophalangeal joint, extend the interphalangeal joints and, to a lesser degree, deviate its digit. The lumbrical muscle (bottom) is ideally placed to initiate flexion of the metacarpophalangeal joint and to exert force on the joint when it is in flexion.

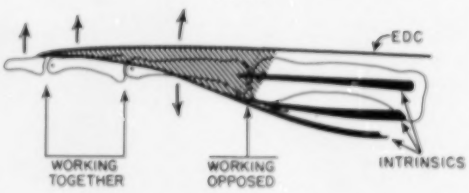

FIG. 9

Fig. 9: At the metacarpophalangeal joint, there exists a synergistic antagonism between the extensor digitorum communis and the intrinsic musculature.

the capsule of the metacarpophalangeal joint and into the base of the proximal phalanx of the digit which it serves. The volar component of each dorsal interosseus is phylogenetically a volar interosseus muscle, and is variably fused to its dorsal component. This component is roughly fusiform, often multipennate, and has an average fiber length slightly greater than its dorsal component. It originates from the carpal ligaments near the base of the metacarpal of the ray it serves and is often partially fused to the adjacent volar interosseus muscle. The tendon of this muscle passes just dorsal to the metacarpal ligament, well below the axis of rotation of the metacarpophalangeal joint. Except in the case of the first dorsal interosseus, the volar component inserts primarily into the lateral band of the extensor aponeurosis with lesser insertion into the capsule of the metacarpophalangeal joint and into the base of the proximal phalanx. In round figures, the first

dorsal interosseus inserts 100 per cent. into bone; the second inserts 60 per cent.; the third inserts only 6 per cent.; and the fourth inserts about 40 per cent. into bone. The remainder of each muscle inserts into the lateral band of the extensor aponeurosis (Fig. 7). Actually the first metacarpal head of the first dorsal interosseus gains some insertion into the transverse fibers of the extensor aponeurosis as well as into the base of the proximal phalanx (Table III). The second metacarpal head of the first dorsal interosseus inserts into the base of the proximal phalanx of the index finger and into the capsule of the metacarpophalangeal joint. The dorsal interossei act to flex the metacarpophalangeal joint, and except for the first dorsal interosseus, to extend the interphalangeal joints. With the metacarpophalangeal joint stabilized in extension by the extensor digitorum communis, they act to abduct the digits from the mid-line. Under special circumstances, the dorsal components of the dorsal interossei may also extend the metacarpophalangeal joints. It is the function of the first metacarpal head of the first dorsal interosseus that is so important in the mechanism of pinch and so difficult to replace surgically when this muscle is paralyzed. The dorsal interossei are normally supplied by the ulnar nerve. By means of microdissection, one can often demonstrate distinct nerve fibers to the dorsal and volar components of the dorsal interosseus muscles. More than one hundred years ago Duchenne unwittingly demonstrated this anatomical fact in his now famous electrophysiological experiments. By the application of a moderate excitatory current over one of the medial dorsal interossei, he was able to demonstrate only abduction of the digit. Stronger current caused flexion of the metacarpophalangeal joint and extension of the interphalangeal joint. The latter action he attributed to the lumbrical. It is more reasonable to suggest that the stronger current was stimulating the motor end-plate of the volar component of the dorsal interosseus with its insertion primarily into the lateral band of the extensor aponeurosis.

Figure 8 reviews briefly the angle of attack of the various components of the intrinsic musculature at the metacarpophalangeal joint. The tendon of the dorsal component of each dorsal interosseus passes almost directly over the axis of rotation of the joint and is capable of extending, flexing, or abducting its phalanx. In burn contractures of the dorsum of the hand, the extensor action simply adds to the hyperextension deformity of the metacarpophalangeal joint. The volar interossei and the volar components of the dorsal interossei attack the joint well below the axis of rotation and are in position to flex the metacarpophalangeal joint more strongly, as well as to extend the interphalangeal joints. With the metacarpophalangeal joints stabilized they can, of course, deviate the digit, but, because of their insertion, with less power than the dorsal component of each dorsal interosseus. Each lumbrical muscle approaches the metacarpophalangeal joint volar to the transverse metacarpal ligament and is mechanically best suited to initiate flexion of the joint and to exert force on the joint when in flexion.

At the metacarpophalangeal joint there exists a synergistic antagonism between the intrinsic musculature and the extensor digitorum communis (Fig. 9). Distal to the proximal interphalangeal joint, the anatomical configuration and the functional potentiality of both the extensor digitorum communis and the intrinsic musculature inserting into the aponeurosis are the same. With the metacarpophalangeal joint stabilized by either the extensor digitorum communis or the intrinsics, the other is capable of completing extension of the digit.

The authors hope that the presentation of this study of the intrinsic mechanism of the hand will stimulate others to investigate this ingenious and finely coordinated mechanism.

REFERENCES

1. Braithwaite, F.; Channell, G. D.; Moore, F. T.; and Whillis, J.: The Applied Anatomy of the Lumbrical and Interosseous Muscles of the Hand. Guy's Hospital Reports, **97**: 185–195, 1948.

(*Continued on page 18*)

INTRINSIC CONTRACTURE IN THE HAND AND ITS SURGICAL TREATMENT *

BY CRAMPTON HARRIS, JR., M.D., AND DANIEL C. RIORDAN, M.D., NEW ORLEANS, LOUISIANA

Contracture of the intrinsic muscles of the hand was first recognized in the Hand Surgery Centers of the large Army General Hospitals during World War II. In these Centers, where great numbers of wounded or injured were concentrated for definitive treatment, it soon became evident that this was an entity hitherto unreported, which is disabling to the patient and which presents a number of problems to the surgeon who attempts to rehabilitate such hands. The first report on this condition was that of Bunnell and his associates in 1948. Since that time, it has been discussed by Littler (1949), by Goldner (1953), and again by Bunnell (1952).

Despite these reports, the condition is not yet generally recognized or fully understood. There are also differences of opinion about which type of treatment should be used, depending on whether the intrinsic muscles are still functioning or whether they are completely fibrotic. The purpose of this paper is to present further observations on this deformity and its surgical treatment.

Intrinsic contracture of the thumb is a related problem and will be dealt with in a later report.

CLINICAL PICTURE

When the intrinsic muscles of the hand undergo contracture, the hand presents deformity which is exactly the opposite of that seen in the claw hand of median-nerve and ulnar-nerve paralysis, or that due to Volkmann's contracture. In these two latter conditions, the wrist is flexed, the metacarpophalangeal joints are hyperextended, and the interphalangeal joints are strongly flexed. The picture is one of complete loss of the intrinsic muscles and has been called by Bunnell the "intrinsic-minus" hand.

FIG. 1

The deformity of the hand in intrinsic contracture. The metacarpophalangeal joints are flexed and the interphalangeal joints are extended. In many cases the distal joint is flexed by the action of the flexor profundus. The thumb may be flexed at the metacarpophalangeal joint and extended at the interphalangeal joint.

Localized contracture gives the impression that the intrinsic muscles are acting to a much greater degree than normal. As shown in Figure 1, the metacarpophalangeal joints are strongly flexed, the metacarpal arch is exaggerated, and the interphalangeal joints are in full extension, with the exception of the distal interphalangeal joint which is often in slight flexion due to the action of the powerful flexor profundus, which overwhelms the extensor action of the contracted intrinsic muscles. The thumb itself is often involved, and presents its own particular form of intrinsic contracture,—the metacarpophalangeal joint is strongly flexed, and the interphalangeal joint is hyperextended. This is the position of the thumb which one would expect, since the intrinsic muscles of the thumb are flexors of the metacarpophalangeal joint and extensors of the interphalangeal joint. Due to adduction contracture, the thumb becomes "clumped" into the palm or strongly adducted against the second metacarpal and index finger. The completely contracted hand has been termed by Bunnell the "intrinsic-plus" hand, and

* Read at the Annual Meeting of the American Society for Surgery of the Hand, Chicago, Illinois, January 23, 1953.

the term is very apt, because the hand assumes the same position in which hyperactivity of the intrinsics would place it. It might also be called the hyperintrinsic hand.

ETIOLOGY

Much has been written on the causation of this condition. With the passage of time and with better recognition of this entity in its milder forms, it has become apparent that the contracture may come about as a result of one or more of the following conditions:

1. *Ischaemia*

Contracture may result when ischaemia of the hand occurs for any reason. As Bunnell has pointed out, many of the patients give a history of injury to the arm, with application of a tight constricting cast which included the hand and was especially tight over the hand. The tight, unyielding cast may act much as does the fascia in the forearm to produce a confined space which does not allow for swelling of the tissues of the hand and does not permit the entry of arterial blood. As a result, the tissues of the hand, nerves, muscles, fascia, tendons, and skin are subjected to prolonged ischaemia, and the muscles undergo fibrosis and contracture.

Other patients may give a history of injury to the arteries in the forearm or the brachial artery above the elbow. One of the patients treated by us was a Korean veteran who had sustained a bullet wound of the brachial artery at the level of the middle of the humerus, without injury to bone, muscle, or nerve. Gangrene of the finger tips developed, and there was a definite question as to whether the hand would survive at all. A sympathectomy was done, and the hand did survive; but the typical picture of ischaemic contracture in the hand developed subsequently (Figs. 2-A, 2-B, 2-C, and 2-D).

FIG. 2-A

Intrinsic contracture due to ischaemia. The patient is trying to make a fist. The thumb is so rigidly adducted that there is no flexion in the index finger at all. Note the bony phalangeal tufts protruding from the ends of the finger tips.

FIG. 2-B

The amount of extension prior to treatment.

2. *Spasm*

Intrinsic contracture may become fixed, if the intrinsic muscles go into spasm and remain so for an extended period. A typical ex-

FIG. 2-C

FIG. 2-D

Figs. 2-C and 2-D: The amount of extension and flexion possible after active splinting for many weeks and surgical release of the intrinsic contracture.

ample of this type of contracture is found in rheumatoid arthritis. In this condition, there is multiple soft-tissue involvement, with inflammation of the synovial membrane, destruction of joint cartilage, extreme pain on motion of the joints, and actual rheumatic involvement of the small muscles of the hand. Because of the painful condition of the joints and the direct involvement of the muscles themselves, the muscles of the hand go into spasm,—first, in order to protect the painful joints; second, because of direct irritation. If the rheumatic process is severe and prolonged, the position of the hand becomes fixed for two reasons,—permanent changes in the joints, and permanent contracture of the small muscles of the hand. This "intrinsic-plus" position of the hand in rheumatoid patients is familiar to all, and is the commonest deformity of the hand in this condition (Fig. 3).

Often in Still's disease, before there is any fixed contracture, clinical testing will show that the small muscles of the hand are in spasm. In certain cases, if the condition subsides, then the spasm disappears and there may be no residual deformity. When the spasm remains for an extended period, the abnormal position of the hand may become permanent.

Another etiological factor in this category is leprosy. In this condition the peripheral nerves are directly attacked by the *Mycobacterium leprae*. There may be rapid and complete destruction of the nerve, which results in loss of function of the intrinsic muscles and a typical claw hand. In other cases where the involvement is more gradual, spasm of the intrinsic muscles is due to the irritative effect of the bacillary infection on the nerve trunk. If the spasm is sufficiently prolonged, the muscles become fixed in the contracted position (Fig. 4).

3. *Fibrosis*

Intrinsic contracture which results from direct fibrosis of the small muscles may be due to a number of causes. One of the typical varieties is that seen following thermal injuries, in which the muscles and soft tissues are damaged or destroyed as a result of direct injury by heat. Subsequent replacement of the muscle by fibrous tissue, which contracts as it becomes mature, results in the typical "intrinsic-plus" deformity. One peculiar aspect of this is the spotty involvement which is often seen in these cases; sometimes all of the fingers of the hand are involved, but very frequently there may be two or more fingers that are contracted, and sometimes only one.

Direct injury to the hand may cause necrosis of the small muscles in one or more areas, and produce spotty involvement of the hand. Figure 5 shows the hand of a worker who was injured when his hand became entangled in a machine, and the skin of the entire dorsum of the thumb was avulsed. This was replaced by a skin graft. Healing

tool place but, as can be seen, there was intrinsic contracture of the index finger and this was the only finger involved.

There is little doubt that with increasing recognition of the condition of intrinsic contracture, new etiological factors will be discovered.

FUNCTIONAL LOSS IN THE INTRINSIC-PLUS HAND

The metacarpophalangeal joints are held in the flexed position and, as a consequence, no abduction of the fingers is possible. The most crippling aspect of the condition is the inability to flex the fingers in any position of the metacarpophalangeal joint except 90 degrees of flexion. The patient is usually capable of making a fist; but, when he attempts to extend the fingers, interphalangeal extension becomes complete, while the metacarpophalangeal joints are still held at 90 degrees of flexion; and only after interphalangeal extension is complete is there any extension at the metacarpophalangeal joints. The fingers sweep through the entire range of the metacarpophalangeal joint, acting as stiff and useless members incapable of normal function (Fig. 7). This results in a crippling loss of such vital functions of the hand as pinch and grasp. As seen in Figure 8, the normal hand, when pinching or grasping, apposes the thumb tip to those of the fingers, the metacarpophalangeal joints of the fingers are flexed at about 45 degrees, and the interphalangeal joints of the finger are gently flexed. In intrinsic contracture, this position of the hand is impossible, because there can be little or no interphalangeal flexion unless the metacarpophalangeal joints are fully flexed. In addition, the thumb is often involved in the contracture and is held clumped into the palm or rigidly adducted; this eliminates the other portion of the pinch or grasp mechanism. All things considered, the deformity is quite as disabling as the reverse deformity of claw-hand.

FIG. 3

Intrinsic contracture as seen in rheumatoid arthritis. This is one of the commonest hand deformities in rheumatic patients.

FIG. 4

Intrinsic contracture in leprosy. Usually the intrinsic muscles are paralyzed, resulting in claw-hand, but an occasional patient has the intrinsic-plus deformity as shown above.

Clinical Test for Intrinsic Contracture

In the normal hand the lumbricales and interossei flex the metacarpophalangeal joints and extend the interphalangeal joints. As with most musculotendinous systems in the

FIG. 5

Intrinsic contracture as a result of direct trauma. The patient was injured over the thumb and web by a machine. The hand subsequently showed intrinsic contracture of the index finger only.

FIG. 6

Some people have the ability to hypercontract the intrinsic muscles voluntarily. This patient's hand is otherwise normal.

body, they have just the right amount of tension to do the things for which they were designed. We may think of the function of intrinsic muscles as having two components,—half of their excursion is directed toward flexing the metacarpophalangeal joints, and half is directed toward extending the interphalangeal joints; there is a very delicate balance between the two. If most of the excursion is used by strongly flexion the interphalangeal joints, then the amount of metacarpophalangeal extension permissible is limited. Thus, in the normal hand with the interphalangeal joints fully flexed, the metacarpophalangeal joints are fixed at approximately 180 degrees. The metacarpophalangeal joints can be hyperextended from 40 to 80 degrees in most individuals by extending the interphalangeal joints to relax the interossei.

In intrinsic contractures of the hand, the situation is the same but to an abnormal degree. The clinical test for the contracture is as follows: If the metacarpophalangeal joints are fully flexed, the interphalangeal joints may be flexed; if the metacarpophalangeal joints are extended, thus using the limited excursion of the intrinsic muscles, then the interphalangeal joints extend and cannot be flexed (even forcibly) as long as the metacarpophalangeal joints are held in extension.

This test for intrinsic contracture is an interesting proof of Fowler's concept of finger extension. He stated that, as long as the metacarpophalangeal joints are extended 180 degrees or less, interphalangeal extension may be performed by either the intrinsic muscles or the long extensors, acting together or separately. In this clinical test we have proved this, because there is a strong action of the intrinsic muscles (due to their contracture) and simply by putting an extensor force on the proximal phalanx with the metacarpophalangeal joint at 180 degrees, complete finger extension is obtained. The long extensor is relaxed by extending the metacarpophalangeal joint, and yet complete active finger extension results, thus adding proof of the correctness of Fowler's theory.

SURGICAL TREATMENT

There have been several different methods of approach to this condition. Perhaps the first suggested is that of interosseus stripping. The origins of all the intrinsic muscles are

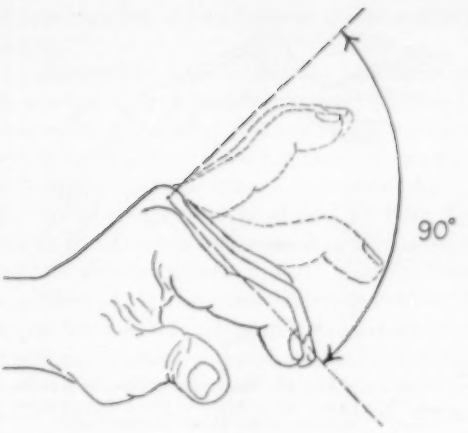

FIG. 7

Fig. 7: Flexion of the fingers, in the intrinsically contracted hand, is possible only when the metacarpophalangeal joints are at 90 degrees of flexion. The fingers are held stiffly in extension throughout the range of the metacarpophalangeal joints; pinch and grasp are therefore impossible.

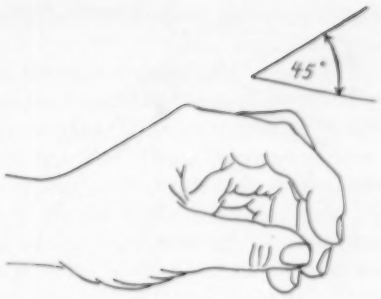

FIG. 8

Fig. 8: In the normal hand, pinch and grasp are usually accomplished with the metacarpophalangeal joints at 45 degrees and the interphalangeal joints gently flexed.

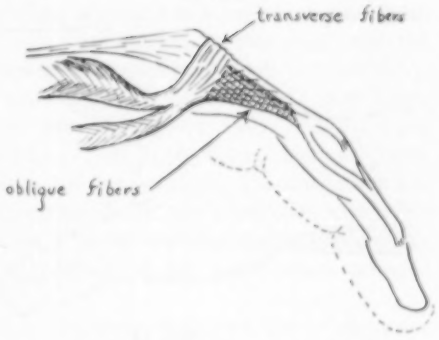

FIG. 9

Fig. 9: The extensor hood at the level of the metacarpophalangeal joints is made up of three components: the long extensor tendon, the transverse fibers which flex the metacarpophalangeal joint, and the oblique fibers which extend the interphalangeal joint.

freed and stripped up from all of the metacarpals and then the hand is put in the claw-hand position and held until the muscles have had a chance to become re-attached in the more distal site. This is a massive procedure; it results in much hemorrhage within the hand; and it necessitates splinting the hand in a non-functional position for a long period. In our experience it has not given good results.

Another method, one suggested by Bunnell, is the sectioning of the lateral bands in the fingers. This is better, much less traumatic, but sometimes results in recurrence of the deformity.

Littler has modified Bunnell's method of lateral-band section, and we believe that this is the treatment of choice in this condition. We term it the Littler "release" operation. The idea behind this operation, and it is a very ingenious one, is to release the extensor component of the intrinsic muscles on the interphalangeal joints, but to preserve the flexor component on the metacarpophalangeal joints. As Figure 9 shows, the extensor hood at the level of the metacarpophalangeal joint is made up of three components,—the long extensor, the transverse fibers of the intrinsic muscles, and, more distally toward the proximal interphalangeal joint, the oblique fibers of the intrinsic muscles which extend the interphalangeal joints. Littler suggested that the oblique fibers be excised, thus releasing the extensor contracture on the interphalangeal joints, but that the transverse fibers which exert a flexor action on the metacarpophalangeal joint be preserved. In Figure 10 the cross-hatched area demarcates that portion of the sleeve to be excised, and Figure 11 shows the appearance of the aponeurosis after this triangular portion has been removed.

One might well ask, "If so much of the extensor aponeurosis is removed, how will the patient be able to achieve interphalangeal extension?" Here again, one must refer to

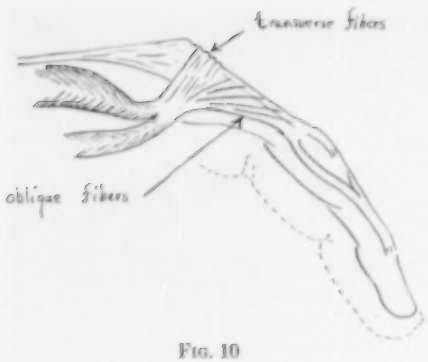

FIG. 10

FIG. 11

FIG. 12

Fig. 10: The cross-hatched area indicates that portion of the extensor aponeurosis which should be resected.

Fig. 11: The appearance of the aponeurosis after a triangular portion of the oblique fibers has been removed. Note that the long extensor tendon and the transverse fibers are carefully preserved.

Fig. 12: The postoperative splint holds the metacarpophalangeal joints at 180 degrees of flexion but allows full function of the interphalangeal joints. This type of active splinting maintains the mobility gained at the time of surgery.

Fowler's concept of finger extension which is that, as long as the metacarpophalangeal joint is not hyperextended, the interphalangeal joints may be completely extended by the long extensor tendon. It is on this very principle that the operation is based, for in this way all intrinsic extensor contracture on the interphalangeal joints can be released and yet interphalangeal extension can be preserved, as long as the transverse fibers of the hood, which prevent metacarpophalangeal hyperextension, are preserved.

The advantage of this procedure is that it restores the important functions of pinch and grasp, preserves finger extension and flexion, and does not in the least diminish the abductor-adductor function of the intrinsic muscles at the metacarpophalangeal joints. In regard to this latter function, we have noticed that many patients appear to have no function in the intrinsic muscles prior to treatment. In many instances this is due to the severe flexion position of the metacarpophalangeal joints, for even the normal hand has no abductor or adductor function at the metacarpophalangeal joints when they are flexed, because of the anatomical construction of the metacarpal head and capsular ligaments. By means of active splinting (with reverse knuckle benders to get the metacarpophalangeal joints out to 180 degrees in cases of severe contracture) and the Littler release operation, these intrinsic muscles seem to appear from nowhere to activate the fingers again. Actually they were present all the time, but could not function because of the flexed position of the metacarpophalangeal joints. For this reason, the question of whether or not the intrinsic muscles are still capable of voluntary function does not apply. This release operation works in either case and, as has been stated, accurate determinations of the condition of the intrinsic muscles before treatment are often impossible; they need not be used as a criterion for determining the type of operation indicated.

Surgical Technique

The procedure is very simple from a surgical standpoint. One should re-emphasize the importance of atraumatic technique. Undue roughness will cause adhesions of the

extensor tendon to the bone of the proximal phalanx and materially interfere with the result.

The authors believe that the best approach is through a single mid-line incision on the dorsum of the proximal phalanx, extending from the level of the metacarpophalangeal joint to about the level of the proximal interphalangeal joint. Through this single incision, both sides of the extensor aponeurosis can be visualized, and the appropriate portion of the extensor aponeurosis can be excised. After the proper portion has been excised, then the interphalangeal joints should be fully flexed, with the metacarpophalangeal joint held at 180 degrees, to ensure that all contractural elements are released. One important point should be restated, namely, that the transverse fibers of the intrinsic muscles must be preserved. If these are transected, then the metacarpophalangeal joint will hyperextend, claw-hand will result, and interphalangeal extension will not be possible. This should be carefully checked at the time of operation, after the oblique fibers have been freed from the long extensor but *before* they are completely excised. At this stage, with the metacarpophalangeal joint in extension, if the interphalangeal joints will not flex fully, the dissection has not been carried far enough proximally. If the interphalangeal joints will flex fully and the metacarpophalangeal joint will not hyperextend, just the right amount of the hood has been dissected and should be excised. If the interphalangeal joints will flex fully and the metacarpophalangeal joints will hyperextend, the dissection has been carried *too far proximally* and the intrinsic insertion should be tacked back with a few sutures to the long extensor and again tested to see if metacarpophalangeal hyperextension is prevented. If this is prevented, only the portion of the hood which remains should be excised.

After completion of the dissection of muscles in the involved fingers, the incisions are closed with a running suture of No. 36 stainless-steel wire, and a pressure dressing is applied. A volar plaster splint is used which extends from the elbow to the middle of the proximal phalanx. This serves to keep the hand in a functional position and prevents any flexion at the metacarpophalangeal joints, yet allows full function of the interphalangeal joints (Fig. 12). Use of the fingers, with the metacarpophalangeal joints held at 180 degrees, preserves the mobility of the fingers which was gained at operation, and the patients are urged to begin full motion of the fingers on the first postoperative day. In this way, with active functional splinting, there is no loss of mobility in the hand during the postoperative period. At the end of ten to fourteen days, the sutures are removed, and a knuckle-bender splint is applied to eliminate any stiffness of the metacarpophalangeal joints that might result from the immobilization.

SUMMARY

Intrinsic contracture in the hand is a crippling entity which is often unrecognized. The hand assumes a typical position with flexion of the metacarpophalangeal joints and extension of the interphalangeal joints. The thumb may be involved, and may exhibit marked flexion of the metacarpophalangeal joint and hyperextension of the interphalangeal joint. The loss of function is considerable,—the patient loses the essential functions of pinch and grasp. There are many possible causes,—ischaemia of the small hand muscles, spasm of the intrinsic muscles as found in rheumatoid arthritis and leprosy, and fibrosis resulting from direct trauma or thermal injuries. The treatment of choice is active splinting coupled with selective surgical excisions of the extensor aponeurosis, as suggested by Littler. The oblique fibers of the extensor hood are removed, thus releasing the extensor contracture; but the transverse fibers are preserved, thus retaining interphalangeal extension. This is best done through a single dorsal mid-line incision. Postoperatively, the patient's hand is splinted with the metacarpophalangeal joints at 180 degrees, but with the interphalangeal joints left free for the active motion that is to begin on the first postoperative day. By means of active splinting and this relatively simple surgical

procedure, the vital functions of pinch and grasp are restored to the intrinsically contracted hand.

Since 1951 we have done this operation on twelve patients. Good results were obtained in all of these patients. One of the early patients in the series demonstrated slight clawing of one finger, due to excessive resection of the transverse fibers of the extensor aponeurosis. This difficulty was not encountered in the later cases in the series.

REFERENCES

Bunnell, Sterling: Surgery of the Hand. Ed. 2. Philadelphia, J. B. Lippincott Company, 1948.

Bunnell, Sterling; Doherty, E. W.; and Curtis, R. M.: Ischemic Contracture, Local, in the Hand. Plast. and Reconstruct. Surg., **3:** 424–433, 1948.

Bunnell, Sterling: Ischaemic Contracture, Local, in the Hand. J. Bone and Joint Surg., **35-A:** 88–101, Jan. 1953.

Duchenne, G. B. A.: Physiology of Motion Demonstrated by Means of Electrical Stimulation and Clinical Observation and Applied to the Study of Paralysis and Deformities. Translated by E. B. Kaplan. Philadelphia, J. B. Lippincott Company, 1949.

Fowler, S. B.: Unpublished paper delivered before the American Society for Surgery of the Hand, January 1946.

Fowler, S. B.: Personal communication.

Goldner, J. L.: Deformities of the Hand Incidental to Pathological Changes of the Extensor and Intrinsic Muscle Mechanisms. J. Bone and Joint Surg., **35-A:** 115–131, Jan. 1953.

Littler, J. W.: Tendon Transfers and Arthrodeses in Combined Median and Ulnar Nerve Paralysis. J. Bone and Joint Surg., **31-A:** 225–234, Apr. 1949.

Littler, J. W.: Personal communication.

Steindler, A.: Arthritic Deformities of the Wrist and Fingers. J. Bone and Joint Surg., **33-A:** 849–862, Oct. 1951.

THE ANATOMY AND FUNCTION OF THE INTRINSIC MUSCULATURE OF THE FINGERS

(*Continued from page 9*)

2. Bunnell, Sterling: Surgery of the Hand, Ed. 2, Philadelphia, J. B. Lippincott Company, 1948.
3. Duchenne, G. B. A.: Physiology of Motion Demonstrated by Means of Electrical Stimulation and Clinical Observation and Applied to the Study of Paralysis and Deformities. Translated by E. B. Kaplan. Philadelphia, J. B. Lippincott Company, 1949.
4. Hartmann, C. G., and Straus, W. L., Jr.: Anatomy of the Rhesus Monkey. Baltimore, Williams and Wilkins Company, 1933.
5. Irwin, C. E.: Problems in Surgical Rehabilitation of the Hand Disabled by Poliomyelitis. *In* Reconstruction Surgery and Traumatology, Annual Survey, Vol. I, p. 216. M. Lange, Editor. Basel, S. Karger, 1953.
6. Poore, G. V.: Nervous Affectations of the Hand. Lancet, **2:** 405–407, 1881.
7. Salisbury, C. R.: The Interosseous Muscles of the Hand. J. Anat., **71:** 395–403, 1937.
8. Sunderland, Sidney: The Actions of the Extensor Digitorum Communis, Interosseous and Lumbrical Muscles. Am. J. Anat., **77:** 189–217, 1945.

DISCUSSION

Dr. S. Benjamin Fowler, Nashville, Tennessee: When the flexor digitorum profundus of a digit, particularly of the index finger, is severed distal to the point of origin of the lumbrical muscle, the flexor digitorum profundus contracts and thus advances the origin of the lumbrical muscle and puts it under stretch. We can often observe in such a finger that the interphalangeal joints cannot be completely flexed with the metacarpophalangeal joint extended. This must be due to advancement of the origin of the lumbrical and to its increased tension, because the interossei themselves have suffered no disturbance. This advancement of the origin of the lumbrical may therefore interfere with flexion of the interphalangeal joints as well as with the excursion of the flexor profundus tendon, and thus compromise the result of a free tendon graft. In instances where it is observed to be tight, the muscle should be sectioned or sacrificed.

Another point of interest in Dr. Eyler's observations was the individuality of the nerve supply to all segments of the intrinsic musculature. His dissection revealed that even in instances when an interosseus

would have two tendons, this muscle had two separate nerve supplies, so that a portion of the muscle could contract independently. This would, of course, aid considerably in performing some of the intricate movements of the finger.

Dr. Harris and Dr. Riordan have beautifully demonstrated the effect of selective sectioning or excision of portions of the extensor aponeurosis to correct the crippling effects of intrinsic-muscle contracture. I am in complete agreement with their operative method and prefer to attack the deformity at the proximal phalanx rather than to attempt stripping of the origin of the muscle. My results, however, have not been as good as those shown, even though I have tried to do the operation in more or less the same way.

In a severe intrinsic-plus hand, the authors note that there may be incomplete extension of the distal phalanx. This is due to hyperextension of the middle phalanx, which then prevents the distal portion of the extensor aponeurosis from acting completely on the distal phalanx. The balance of the extensor aponeurosis is delicate, and when a flexion or extension deformity of the proximal interphalangeal joint exists, the distal joint tends to assume a reverse deformity almost equal in degree. The proximal interphalangeal joint often tends likewise to reverse the deformity of the distal phalanx, if that deformity is due to a lengthening or shortening of the distal segment of the extensor aponeurosis. In the intrinsic-plus hand, occasionally a lengthening of the central slip over the distal end of the proximal phalanx will restore balance to the finger and produce effective extension of the distal phalanx. In some of our patients we have simply been unable to get the metacarpophalangeal joint to extend to 180 degrees after intrinsic sectioning because of contracture of the anterior capsule.

It should also be noted that in a paralysis of intrinsic muscles due to a nerve lesion, a little ischaemia of the intrinsic muscles is often a good thing as they will stabilize the metacarpophalangeal joints to the extent that the long extensor tendons can afford very satisfactory extension of the interphalangeal joints.

Dr. J. William Littler, New York, N. Y.: The intrinsic lumbrical and volar interossei serve primarily to flex the metacarpophalangeal joints, thus maintaining the longitudinal arch of the hand. These muscles are balanced by the long finger extensors and both systems act coordinately to extend the interphalangeal joints.

Contracture or paralysis of the intrinsic musculature will disrupt the longitudinal arch. Both conditions require corrective procedures through intrinsic-tendon release, tendon transfer, or metacarpophalangeal arthrodesis, if finger function is to be restored.

A mild contracture of the intrinsic muscles in median-nerve and ulnar-nerve paralysis prevents hyperextension of the proximal phalanx.

A severe ischaemic intrinsic-muscle contracture may result from a constricting plaster cast which compresses the metacarpals, so that extreme care must be exercised whenever plaster is utilized for immobilization. An injured hand, properly immobilized and elevated, should be reasonably comfortable,—excessive or persistent pain often indicates an excessively tight dressing and relief is mandatory for the prevention of ischaemic complications in skin and muscle.

Dr. Eyler's illustrative work on the anatomy and function of the intrinsic musculature aids materially in substantiating clinical impressions and in providing a sound anatomical background for the understanding of function and the disability incident to its loss.

Dr. Sterling Bunnell, San Francisco, California: The authors have given us an accurate description of the lumbricales and the volar and dorsal interossei. They have shown us how the lumbricales, which have a fifty-millimeter muscle-fiber length and consequently a long excursion, have also a 35-degree angle of approach and so initiate flexion of the metacarpophalangeal joints. They also have shown that the interossei with a twenty-five-millimeter muscle-fiber length and only a 25-degree angle of approach have a shorter but a stronger pull.

They have shown how the intrinsic muscles stabilize the metacarpophalangeal joints in flexion so that the long extensors can extend the interphalangeal joints and how the long extensors stabilize the metacarpophalangeal joints in extension so that the intrinsics can give lateral motion and extend the interphalangeal joints.

This synergistic and coordinated action allows the long extensors better to extend the interphalangeal joints when the metacarpophalangeal joints are flexed, and the intrinsics better to extend the interphalangeal joints when the metacarpophalangeal joints are extended.

Dr. Harris and Dr. Riordan have pointed out that the deformity is the opposite of that in Volkmann's ischaemic contracture, being intrinsic plus instead of intrinsic minus as is seen in median-nerve and ulnar-nerve palsy. Though many cases show a combination of the two conditions, they are essentially distinct. On discovering this condition in the hand and in order to distinguish it from Volkmann's ischaemic contracture, I gave it the rather ponderous name "ischaemic contracture, local, in the hand".* We must also,

* Bunnell, Sterling: Ischaemic Contracture, Local, in the Hand. J. Bone and Joint Surg., **35-A**: 88–101, Jan. 1953.

however, consider cases of intrinsic contracture that do not develop from ischaemia, such as muscle fibrosis in rheumatoid arthritis, and even functional postures that have become fixed from long duration. The authors include the early spasm accompanying both rheumatoid arthritis and some cases of leprosy. Perhaps a fitting term for the condition is intrinsic contracture of the hand. This would include the ischaemic and the non-ischaemic contractures. The ischaemic type is common in all degrees of severity.

To me it seems that the main handicap is the inability to open the hand for grasp; to the authors it is the inability to flex the interphalangeal joints unless the metacarpophalangeal joints are flexed to a right angle. There is a difference here in the fundamental conception and so also in the treatment. In the true ischaemic cases, the metacarpophalangeal joints of both fingers and thumb are drawn into strong flexion and the interphalangeal joints are in extension. These hands can always make a fist for grasping, but they cannot open for grasp.

Therefore, the two methods of treatment I have used are either to strip the interossei and displace them distally to relax the lateral bands, or to break the continuity of the lateral bands themselves.

The stripping operation is done through two dorsal incisions. The curved elevator hugs close to the metacarpals, minimizing the bleeding, and the immobilization in the clawed position is for only a few days. If this procedure does not allow the metacarpophalangeal joints to straighten with the interphalangeal joints in full flexion because of too much general fibrosis and many adhesions about the metacarpal head, the lateral bands are attended to. By a short incision through the dorsum of each of the three webs, the lateral bands are either tenotomized or, as there is some tendency for them to rejoin, a segment extending down the finger is removed from some. Even so, in some ischaemic cases more has to be done to allow the metacarpophalangeal joint to extend, such as severing the collateral ligaments and the volar capsular ligament. All of the tissue of the hand suffers to some extent in this condition of ischaemic hand and often such dense cicatrix develops about the metacarpal heads that the tendons of the interossei are densely adherent at that point. Anyone who has dissected out the solid cicatrix of ischaemic muscles in an ischaemic thumb-cleft contracture realizes the absolutely unyielding quality of the scar. The transverse fibers are not cut. It should be remembered that the contracture is in the muscles, not in the lateral bands, so that the tenotomy should be proximal to allow the metacarpophalangeal joints to extend, instead of distal in the dorsal aponeurosis.

Our main problem is to make the metacarpophalangeal joints extend. They never have gone into hyperextension. We have no trouble in making the interphalangeal joints flex whenever the lateral bands are severed at any point in their lengths. These hands as a whole, and especially the muscles, are usually so cicatricial that we do not hope for a perfect result. If we can obtain better opening for grasp, it is all we can expect.

It is readily conceivable that in some mild cases the element of dense ischaemic cicatrix is not so great as it is in leprosy and other cases, so on removal of the lateral bands distal to the transverse fibers the interossei can gradually be drawn out by elastic splints. This would be impossible in patients with severe ischaemia who need severance of the lateral band proximal to the aponeurosis, and even removal of a segment of the lateral band.

For patients who still have soft tissue and elastic interosseus muscle, the operation described by the authors may be sufficient to restore nice muscle balance for function. For the major cases of ischaemia, however, I am sure that more radical means are necessary.

Dr. Paul Brand, Vellore, India: I would like to make two observations, the first in regard to artificial production of this intrinsic force phenomenon. During the past five years we have done more than 300 tendon transplantations in the hand, employing the Bunnell operation. During these numerous operations we have had occasion to put considerable tension on the tendons. When the transplant to the tendon of the lumbrical muscle is under too much tension, this phenomenon is produced. In two cases where this happened we have not been too disappointed with the result. The flexion of the distal phalangeal joint and the function of the hand are pretty good. The patients have an important factor, a good grasping mechanism. It is merely the action of the intrinsic muscles which produces too much tension.

The second observation is that people in whom the claw hand is developing because of median-nerve palsy have better use of the hand afterwards, if they were able to hyperextend the metacarpophalangeal joint before the claw hand developed; they can push the metacarpophalangeal joint into flexion. While they are flexing the hand they are able to have a normal grasping motion even with the claw hand. They grasp very well. That is not due to the intrinsic contracture. In the movie demonstration of the patient with leprosy we saw nice pronation action with hyperextension of the interphalangeal joint; I suspect that the patient had no intrinsic contracture and that before the leprosy developed he was able to hyperextend the metacarpophalangeal joint. The Indian women are very proud of their hyperextended metacarpophalangeal joints. When they contract leprosy they are far less likely to have claw-hand than are the men, who do not have the hyperextended joints.

THE CORNPICKER HAND *†

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The "cornpicker hand" is a term used to describe a specific type of hand injury, commonly seen in the Corn Belt, which is produced by catching the hand in the moving mechanism of the mechanical cornpicker and results in mutilating trauma. Most of these injuries have in common the extensive damage to soft tissue, associated with compound fractures of the digits and possible traumatic amputations. Many problems are presented in the treatment and reconstruction of a hand thus injured.

The lack of published material on this subject justifies a description of this condition. Hardin and Robinson described several cases and presented the problem in 1950, mostly from the viewpoint of plastic surgery. Young and Ghormley made brief mention of this injury as a separate entity in their text. There must be other similar hand injuries common

Fig. 1: Typical severe cornpicker injury before débridement. In this case, all the fingers and the distal portion of the thumb have been lost.

Fig. 2: A typical severe cornpicker hand after a split-thickness graft has been completed and a pedicle has been raised on the abdomen.

FIG. 1

FIG. 2

* Read at the Annual Meeting of the American Society for Surgery of the Hand, Chicago, Illinois, January 22, 1953.

† Sponsored by the Veterans Administration and published with the approval of the Chief Medical Director. The statements and conclusions published by the authors are a result of their own study and do not necessarily reflect the opinion or policy of the Veterans Administration.

FIG. 3-B

FIG. 3-C

FIG. 3-A

Roentgenograms illustrating various injuries to bone structure. Most important is the fact that in all these there is a severe necrotizing effect on the soft tissues.

Fig. 3-A: In this instance, there were only a few linear fractures in the proximal phalanx of the middle finger, but the soft-tissue injury was extensive and all the digits with the exception of the thumb were lost, although amputation was deferred for over a week. The patient was given multiple stellate-ganglion blocks.

Fig. 3-B: This shows the type of compound wounds that are frequently associated with these injuries. In this case all the digits were also lost.

Fig. 3-C: A hand with complete traumatic amputation of all the digits with the exception of the thumb.

to the operation of certain machines, but a careful search of the literature failed to reveal any detailed information about them.

Tractors and machinery of all types head the list of causes of farm accidents. The mechanical cornpicker, a very useful harvesting tool which is perfectly safe when rules are followed, may be added to that list. However, haste and familiarity make many workers victims of their own carelessness.

The mechanical cornpicker is a mobile piece of farm machinery which is usually propelled by a tractor. It consists of a series of rollers, belts, cutting knives, and a conveyer. It extends the picker, snaps the ears of corn off the stalk, removes the husks, and deposits the clean ears in a wagon. However, the chief difficulty associated with its use is its tendency to become clogged and jammed by pieces of cornstalks or husks. If an attempt is made to remove the offending object without shutting off the power, the hand may very quickly become caught in the mechanism as the rollers and belts start moving again. Usually the glove is caught, pulling in the fingers on the ulnar aspect of the hand. Progress through the rollers frequently is limited by the breadth of the palm and the metacarpal heads. Shutting off the power before extracting the obstacle would prevent

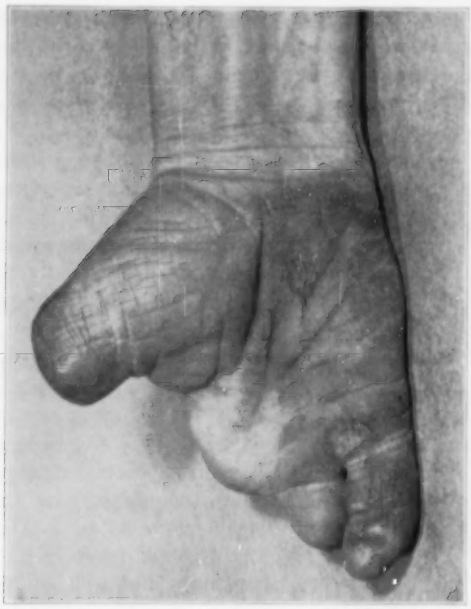

FIG. 4-A

FIG. 4-B

Fig. 4-A: A case of severe bilateral involvement. Since there was a portion of the thumb and part of the little and ring fingers remaining on the right hand, the cleft was deepened by removing the second metacarpal so that this patient would be able to grasp between the thumb and the little finger. There was ankylosis of the proximal joint of the little finger, so a rotational osteotomy was done, which rotated the distal portion of the digit to make it oppose the thumb.

Fig. 4-B: The other hand shows almost complete loss of the thumb and of all of the fingers. A clefting procedure was recommended so that the patient would be able to pinch between the thenar and hypothenar eminences, but he did not wish any more surgery. He carries on with farming without using any prosthetic appliances and can grasp very firmly between the thumb and the little finger, which has about 90 degrees of flexion at the metacarpophalangeal joint. He can drive a tractor well, and can hold a match firmly in this hand.

such catastrophes but would take slightly more time. Frequently the man running the machine has been working alone and may be too far out to get help by simply calling for it when he is in trouble. His hand may remain trapped and sustain continued trauma because he is unable to reach the controls. Clothing often becomes caught in the machine, further complicating the situation. It has not been uncommon for a man to have to amputate one or more fingers with a pocket-knife in order to free his hand. Fortunately the crushing and burning usually control any hemorrhage present.

During every cornpicking season, at least three or four patients with severely injured cornpicker hands are treated in our Veterans Hospitals in Nebraska and by our Clinic group. These represent only a small fraction of the total cornpicker injuries which occur throughout the State, because many more are treated elsewhere. The cases illustrated here were selected from twenty-eight patients with cornpicker hand injuries who have been treated by us over the past few years.

The treatment of the cornpicker hand is usually prolonged and requires multiple surgical procedures, if one is to avoid the much simpler solution of an amputation proximal to the wrist joint. It has been our policy to save as much as possible of the hand and fingers, and to reconstruct the hand with whatever remains. Regardless of how little of the hand is finally left, most patients find that they can make good use of it and are pleased to have even a part of the hand.

Almost all cornpicker hand injuries are severe; they represent a combination of lacerations, crushing, avulsion, and friction burns. They are very dirty wounds, and at

first inspection it may not seem feasible to salvage any portion of the hand (Fig. 1). However, it has been shown by Bunnell and many others in recent literature [1, 2, 4, 6, 8] that it is best to be somewhat conservative in the primary débridement of hand injuries, and to postpone amputation if there is any chance at all for viability of the tissue. We prefer to treat the patient as soon after the injury as possible and, in cases where he is being referred by another doctor, we ask that time not be taken to do an initial débridement but that the hand simply be wrapped in a sterile pressure dressing. Since hemorrhage has not been very extensive in most cases, these patients are usually not in shock; however, neurogenic shock is seen in those who have sustained extensive or prolonged trauma. When it is present, the problem of shock is managed by the usual means. Roentgenograms are taken without disturbing the dressing. The patient is taken to the operating room and given a general anaesthetic if at all possible; otherwise a brachial block is used. The use of a tourniquet is avoided whenever possible, in order to afford a better opportunity to judge the status of circulation in the tissues, but a tourniquet is always placed in position on the arm in case it

FIG. 5-A

FIG. 5-B

FIG. 5-C

This is another case in which there has been removal of more than one of the metacarpals in order to deepen the cleft and to enable the patient to oppose the thumb with the remaining digit, which is the little finger in this case. It is advisable to leave as much breadth as possible to the palm as long as there can be some opposition for pinch.

may be needed. The skin injuries about the wound are cleansed. Ether is used to remove grease, and the dirt is removed by scrubbing with pHisoderm or similar soap. The wounds themselves are then copiously irrigated with normal saline solution. Antiseptics are not used in the wounds. Débridement of completely non-viable tissue, protruding bone, and protruding tendons is carried out. If there are areas of questionable viability in the soft tissues, these may be left undisturbed for a few days and carefully watched. Frequently by the time the débridement has been completed, one or more digits may have been amputated, and there may be large defects in either the palmar or dorsal surfaces of the hand. Repair of tendons and other deep structures is usually not performed at this time because of potential infection and the nature of the wound. Primary closure of the wounds may be attempted in areas where there is enough skin, but frequently this is not possible. Length of the digits is never sacrificed to facilitate primary closure; rather we employ, if possible, a split-thickness skin graft. This may be applied immediately or a few days later. It is applied later whenever tissue of questionable viability is left behind. Compression dressings are then applied to the hand to reduce postoperative oedema. At the time a split-thickness graft is applied, a preliminary decision is made regarding eventual coverage by a pedicle graft. If it appears probable that a pedicle graft will eventually be necessary, a tube pedicle is formed on the anterior abdominal wall immediately or a flap is raised for smaller areas. This saves time for the patient, because the tube will then be ready for attachment by the time the hand is ready to receive it (Fig. 2).

FIG. 6-A

FIG. 6-B

In this particular patient, the radial aspect of the hand was caught in the cornpicker and the index and middle fingers were lost, although the thumb was saved. However, there was extensive fibrosis and osteomyelitis with ankylosis of the thumb. A deepening of the cleft between the thumb and ring finger was done with removal of the index and middle finger rays; an osteotomy was carried out to rotate the thumb so that he could grasp between it and the ring finger. In this case, two pedicle grafts were necessary,—one to cover the main portion of the hand and the remaining digits and the other to cover the thumb. This man is continuing to gain strength and skill in this hand. He can bring the thumb against the ring finger with enough power to support articles of clothing. He has a range of motion of one and one-half inches of the distal portion of the thumb. Although he has very little motion in the fingers themselves, he can carry pails of water, using these fingers as hooks, and is able to grip well enough to hold a pair of pliers between the thumb and the fingers, or to control the steering wheel of a car. There has been no ulceration of skin, and sensation is improving. The patient prefers what he has to a forearm prosthesis.

In the immediate post-

FIG. 7-A

FIG. 7-B

FIG. 7-C

This case illustrates the multiple procedures frequently needed to salvage a portion of the hand. A full-thickness graft was required here and a rather thick fat pad was left as it had value in the grafting of extensor tendons to the digit. There were multiple compound fractures of all the fingers from the second to the fifth; the little finger had to be amputated early and the ring finger later became gangrenous and was amputated. Sequestrectomies were then done because of osteomyelitis of the proximal phalanx of the index finger. Usually there is extensive necrosis of tissue with thrombosis of the vessels and even though the digit may be saved, there frequently is a fibrous ankylosis of the fingers. However, they are still of value, for this patient can grasp and pinch even though the interphalangeal joints are ankylosed in the position demonstrated. He is able to utilize the fingers as hooks, since he has free motion at the metacarpophalangeal joint.

operative period, antibiotics are used prophylactically. The patient is given either a booster injection of tetanus toxoid or tetanus and gas bacillus antitoxin. Vasospasm is combated and collateral circulation is stimulated by the use of intravenous procaine, stellate-ganglion blocks, and priscoline; these may be used singly or in combination. As mentioned previously, primary débridement is conservative and amputation is postponed when possible. Most frequently there are associated fractures, very often compounded, and even traumatic amputations, but in all cases there is usually a severe necrotizing effect on the soft tissues, regardless of the degree of bone involvement (Figs. 3-A, 3-B, and 3-C). Dressings are not disturbed for several days unless the patient shows signs of either local or systemic infection. Further débridement may be necessary within seven to ten days, but by that time there should be no question of the line of demarcation between viable and non-viable tissue. Further grafting with split-thickness skin may be required to finish covering the open wounds. We do not risk a primary full-thickness graft.

During the period while the hand is healing, one end of the abdominal tube pedicle may be delayed one or more times preparatory to migration, in order to establish a better blood supply through the other end. If the area to be covered is extensive, then a "pancake" of skin from the abdominal wall may be included with the end of the pedicle.

By the time the hand is past the stage of acute reaction to the trauma and the wounds are healed, a definite plan of reconstruction with function for its goal has been formulated. Patients with this injury are usually more interested in a usable member than in a purely cosmetic result. If a definite plan of procedure is evolved, fewer operations are necessary and the patient will be able to return to work sooner. One may have to compromise at times, because the patient may not be willing to spend the time required to obtain an ideal result. In any case, however, there is the limiting factor that only

FIG. 8-A

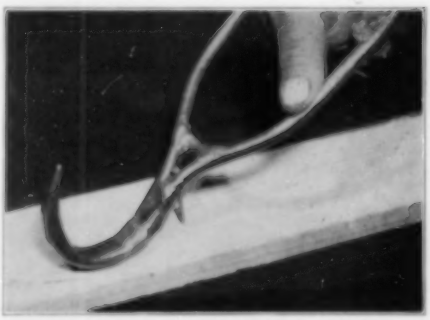

FIG. 8-B

This is one of the general utility prostheses improvised by the patient. The hook on this appliance can support his weight of 200 pounds. He can withdraw nails by the use of the small opening in the prosthesis; he can also hammer. He can grasp with his thumb against the side of the hook. He feels that with his prosthesis he can do more without needing other tools than he was able to do before he was injured. Patients with this injury are not primarily interested in the cosmetic aspects, and one of the chief disadvantages of any commercial prosthetic appliance is that it will not withstand the strain of heavy farm work.

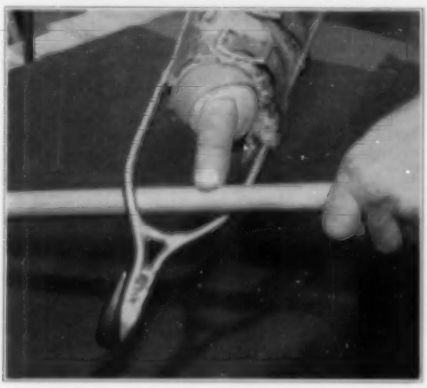

FIG. 8-C

certain structures remain for reconstruction. In a few instances, there has been bilateral involvement of the hands, and reconstruction in these cases has been of special importance (Figs. 4-A and 4-B).

It would not be practical to discuss all the possibilities in reconstruction of these severely injured hands. The same principles which apply to hands similarly injured by other forms of trauma may apply to these cases. In severe injuries of this nature, one is commonly confronted with three main types: (1) the loss of all fingers, with preservation of the thumb; (2) the loss of all fingers and the thumb; (3) the loss of the thumb including one or more of the fingers on the radial aspect of the hand. In many cases it may be important eventually to create a cleft in the hand to form a pinching surface between the thenar and hypothenar areas or to increase the function of grasp between remnants of a digit and the thumb (Figs. 5-A, 5-B, and 5-C); this is done by the removal of one or more metacarpals. In those hands in which there has been a loss of the thumb with the digits remaining, transposition of the index finger is the most satisfactory procedure, although loss of the thumb without other involvement is rare.

Usually some coverage with pedicle skin is necessary. If a pedicle graft is applied, it may be best not to remove fat from the graft, because the subcutaneous fat will provide an excellent gliding bed for tendons. In those hands which are less severely involved, nerve suture and tendon suture or graft may be all that is necessary after coverage has been provided. Other work upon soft tissues, such as excision of the collateral ligaments of the metacarpophalangeal joints, may be of value, but it is rarely possible to carry out intrinsic reconstruction in these hands. Most of these injuries will require some type of bone repair (Figs. 6-A and 6-B). This work should be completed after, or in conjunction with, the transfer of the tube pedicle and before nerve or tendon repair is attempted. In addition to providing a deeper and more functional thumb cleft by removal of one or more

FIG. 9-A

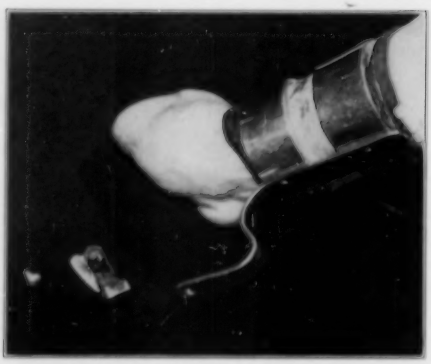

FIG. 9-B

FIG. 9-C

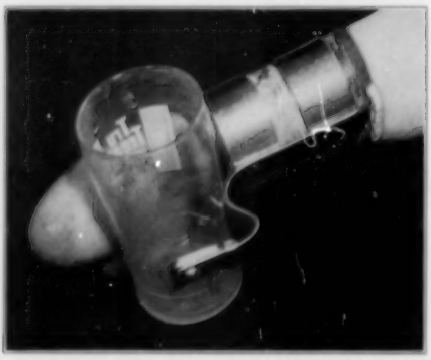

FIG. 9-D

FIG. 9-E

FIG. 9-F

In the event of a severe injury which results in the loss of all of the digits and the thumb, this prosthesis which is of simple design, enables the patient to utilize the remnant of the hand and wrist flexion in the grasping of objects against the projecting appendage. The hook is used for carrying objects such as pails, and the projecting portion can be used either for thrust or for pull in the handling of machinery. There is also a small removable attachment which is notched to stabilize small implements such as a pen or fork. The flared shape of the end of this attachment made it impractical to incorporate it in the appendage, and so it was made removable. The patient writes with the affected hand and does all normal farm work.

metacarpals, the surgeon may have to arthrodese one or more interphalangeal joints, and even fuse the metacarpophalangeal joints. If all the fingers have been amputated at or near the metacarpophalangeal joints, some phalangeal function may be provided by the procedure of phalangization. This consists in separating the metacarpals from one another

and producing clefts between them. From the viewpoint of the average farmer, however, the value of this last procedure is questionable. It is wise to guide the patient in his decision as to how far the reconstructive work should go before the work is actually started. The chances for improvement from each procedure can be explained to the patient and then he can decide whether or not it would be worth while to him. Two or more procedures will usually be necessary (Figs. 7-A, 7-B, and 7-C).

There may be cases in which, after the surgical work has been completed, some type of prosthesis would be helpful in gaining further function of the reconstructed hand. Unfortunately, such appliances are not easily obtained. Most limb makers are reluctant to design a prosthesis which utilizes the wrist motion. Many times both the patient and the surgeon are impatient, and so amputation in the forearm is carried out. The possibilities of hand prostheses have hardly been explored. One dislikes the thought of sacrificing a useful portion of the hand simply because a suitable prosthetic appliance is not available. Appliances are obtainable for injuries involving loss of the fingers, but with the thumb remaining, although the commercial variety is generally not strong enough to be of much use in the occupation of farming (Figs. 8-A, 8-B, and 8-C). There is a useful prosthesis for those with disarticulation at the wrist; it has the advantage of rotation of the forearm and a less bulky harness attachment, although it does have the slight disadvantage of being longer than the normal extremity. It is amazing, however, to see how efficiently some simple homemade types of prostheses are utilized by patients who have lost all the digits and the thumb; they may thus make use of the palm of the hand and flexion and rotation of the wrist (Figs. 9-A to 9-F).

Generally, the plan of procedure described has been carried out in most of our cases, although a few patients have requested forearm amputations. It may not be possible to produce a cosmetic end result, but any procedure which will promote function is worth while. Most patients find that even a portion of a functional hand is useful to them in their occupation of farming. Some attempt should be made to develop functional prosthetic appliances for these hands, in order to encourage utilization of every bit of the hand which can possibly be saved.

REFERENCES

1. Barron, J. N.: The Skin of the Hand: The Immediate Treatment of Crush Injuries and Lacerations. Post Graduate Med. J., **23**: 453–468, 1947.
2. Brown, J. B.; Cannon, Bradford; Graham, W. C.; Lischer, C. E.; Scarborough, C. P.; Davis, W. B.; and Moore, A. M.: Direct Flap Repair of Defects of the Arm and Hand: Preparation of Gunshot Wounds for Repair of Nerves, Bones and Tendons. Ann. Surg., **122**: 706–715, 1945.
3. Bunnell, Sterling: Surgery of the Hand, Ed. 2. Philadelphia, J. B. Lippincott Company, 1948.
4. Findlay, R. T.: Conservative Treatment vs. Immediate Amputation in Severe Crushing Injuries of the Hand and Forearm. Surg. Clin. North America, **18**: 297–303, 1938.
5. Hardin, C. A., and Robinson, D. W.: Compound Injuries of the Hand Due to the Mechanical Corn Picker. Kansas Med. Soc. J., **51**: 114–118, 1950.
6. McDonald, J. J., and Webster, J. P.; Early Covering of Extensive Traumatic Deformities. Plast. and Reconst. Surg., **1**: 49–57, 1946.
7. Thomson, J. E. M., and Peterson, L. T.: Care of Hand Injuries, Part II: Requirements of Early Definitive Treatment. Nebraska Med. J., **33**: 427, 1948.
8. Young, H. H., and Ghormley, R. K.: Accidents on the Farm. J. Am. Med. Assn., **132**: 768–771, 1946.

DISCUSSION

Dr. Julian M. Bruner, Des Moines, Iowa: Dr. Webster has presented this timely subject clearly and concisely, and the principles of treatment advocated by him are sound and practical. During the past season, seven severe cases were seen by us at veterans and private hospitals. The most common type of this serious injury has been the amputation of fingers; the thumb and the fifth finger escape injury most frequently. Usually the metacarpal region is also severely damaged in its distal portion, and the soft tissue overlying the metacarpal heads is severely crushed.

Since many of these wounds are grossly contaminated with soil, and since débridement is often neces-

(*Continued on page 126*)

COMPLICATIONS IN REPLACEMENT ARTHROPLASTY OF THE HIP*†

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The operation known as replacement arthroplasty of the hip is enjoying a popularity rarely accorded a surgical procedure which has not passed the test of time. Certainly in this country follow-up studies of a statistically valid series of cases have not been of sufficient duration to permit a true appraisal of the merits of this operation [1,4,5,6]. Even the five-year follow-up study reported by Judet and Judet [3] cannot justify a final evaluation.

Despite allegations to the contrary, substitution of a portion of the hip joint by a prosthetic appliance is a surgical procedure of some magnitude, and is inevitably attended by a variety of complications. In this study, no attempt has been made to evaluate indications or to pass judgment on end results. Cases were investigated for the primary purpose of studying events during surgery and in the postoperative period which could be considered surgical complications.

TABLE I

REPLACEMENT ARTHROPLASTY OF THE HIP

	No.	*Per cent.*
No. of patients	40	
Male	27	67.5
Female	13	32.5
No. of prostheses	45	
Judet	39	86.7
Eicher	5	11.1
Jaenichen-Collison	1	2.2
Patients with one complication or more	23	57.5
No. of complications	53	
Preoperative diagnoses		
Degenerative arthritis	20	44.4
Recent intracapsular fractures	11	24.4
Old intracapsular fractures with non-union	7	15.5
Rheumatoid arthritis	4	8.9
Healed intracapsular fractures with aseptic necrosis	3	6.7

We have had personal experience with forty patients having a total of forty-five replacement arthroplasties of the hip. Most of these patients were operated upon at Wadsworth General Hospital, Veterans Administration Center, Los Angeles, California. The operations were performed by a number of surgeons on the Staff of this Hospital.

Of the forty patients studied in this series (Table I), the ages varied from twenty-five to eighty-three years. Thirteen were female and twenty-seven were male. This group of patients had a total number of forty-five replacement arthroplasties. Thirty-nine of the prostheses were of the Judet type, five were of the Eicher variety, and one was of the Jaenichen-Collison type. Four of the patients underwent bilateral operations. Table II lists the types of complications encountered in this study.

* Based on a scientific exhibit at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Chicago, Illinois, January 24 to 29, 1953.

† Read at the Annual Meeting of the Western Orthopedic Association, Coronado, California, October 16, 1952.

Deaths

There were a total of six deaths. Three occurred in the first month after operation. The earliest death took place five days postoperatively. This patient was a woman, eighty-three years old, who was severely debilitated and had been considered a poor surgical risk. She died of bronchopneumonia. The next earliest death occurred in a man, seventy-three years old, who died two weeks after surgery of a pulmonary embolism. The third death occurred one month postoperatively in a sixty-year-old male who underwent surgical revision for persistent dislocation of an acrylic prosthesis. In this patient pneumonitis and septicaemia developed which were refractory to antibiotics. At autopsy multiple septic emboli were found with infarction of the brain, spleen, and both kidneys. The fourth death occurred in a female, seventy-nine years old, who was senile, debilitated, and malnourished. A sacral decubitus ulcer developed one week after operation. She became apathetic and disoriented and suffered a gradual downhill course until she died two months postoperatively with bronchopneumonia. Our two other deaths were caused by cerebral vascular accidents, three months and seven months after operation, respectively. These two deaths cannot be properly considered postoperative complications, but are included for the sake of completeness.

Dislocation

Five postoperative dislocations (11 per cent.), all of the anterosuperior type*, occurred in our series. Four dislocations occurred in patients who had Judet prostheses and one in a patient with an Eicher appliance. Dislocations occurred after all the surgical exposures used in this series—that is, the posterior, anterolateral, and antero-iliofemoral approaches. The earliest dislocation occurred on the first postoperative day. The dislocation was easily reduced when the hip was placed in abduction and internal rotation. The next earliest dislocation occurred in the second postoperative week. This patient was a sixty-year-old, obese, apathetic male, who was placed in suspension traction postoperatively. A decubitus ulcer developed at the end of the first week and for this reason the patient was turned frequently in bed; apparently the dislocation occurred during these manoeuvres. Repeated attempts at closed reduction were unsuccessful. Open surgery was performed and reduction was accomplished only after removal of extensive intra-articular granulation tissue. In this patient pneumonitis and multiple septic emboli developed, and he died four weeks after operation. In the third patient a postoperative hematoma developed and subsequently the hip dislocated. Cultures of a specimen from the hematoma failed to reveal evidence of infection. The wound was opened and allowed to drain. Spontaneous reduction quickly occurred following drainage when the extremity was placed in traction and abduction. The fourth patient had an uneventful course for the first two weeks, during which time his extremities were maintained in abduction by means of an A bar. The A bar was removed at the end of two weeks and hip motion was begun. Dislocation occurred the first day after removal of the plaster. Reduction was easily accomplished by traction together with abduction and internal rotation. The fifth dislocation occurred in an elderly disoriented female when she fell out of bed during the second week after operation. In this case reduction again was easily accomplished by closed manipulation.

The following conditions appear to be significant predisposing factors to postoperative dislocations:

1. Insufficient length of femoral neck;

* Since compilation of the statistical study in this report, one patient has suffered a posterosuperior dislocation during immobilization in an abduction-internal-rotation boot. Closed reduction was accomplished and maintained by immobilization of the hip in abduction and external rotation (Fig. 7).

FIG. 1

Superior and central migration occurred during the early postoperative period in a patient with rheumatoid arthritis.

2. Inadequate depth of acetabular cavity;
3. Excessive valgus placement of prosthesis.

In the presence of one or more of these conditions, dislocation is usually readily demonstrable at the time of surgery if the hip is placed in adduction and external rotation. In such cases postoperative immobilization for a minimum of three weeks in abduction and internal rotation has been employed.

Superior Subluxation

Superior subluxation was noted in ten cases (22 per cent.). This condition is characterized by a migration of the proximal portion of the femur superiorly and often centrally, producing what appears to be a subluxation of the head of the prosthesis. There has been no demonstrable change in the relationship between the prosthesis and the neck of the femur. In some cases the subluxation was observed in the period immediately after operation; in others it was not detected until six months after surgery. This condition can be regarded as an abortive postoperative dislocation and appears to be associated with the same predisposing factors as those listed under "Dislocations". In addition to these, a factor encountered at surgery in two cases should be mentioned. This consisted of actual erosion of subchondral bone of the roof and central portion of the acetabulum. So far, no specific symptoms have been definitely attributed to this condition. Three of the ten patients previously had had frank postoperative dislocations which apparently had been satisfactorily reduced. All four of the patients with rheumatoid arthritis in this series suffered this complication (Fig. 1). Another patient had sustained an unreduced traumatic dislocation of the hip fifteen months before replacement arthroplasty and, although at surgery reduction appeared adequate, during the six-month postoperative period superior subluxation gradually appeared. The remaining two cases occurred in patients with non-union of an intracapsular fracture and degenerative arthritis respectively.

TABLE II

DEATHS AND COMPLICATIONS

No. of patients	40	
No. of prostheses	45	
	No.	*Per cent.*
Deaths	4	10.0
Dislocations (anterosuperior)	5	11.1
Superior subluxations	10	22.2
Paracapsular calcification	9	20.0
Pain at the site of stem protrusion	3	6.7
Protrusion of Eicher stem through cortex	2	4.4
Varus deformity of prosthesis	2	4.4
Fracture of the femur	2	4.4
Avulsion of the greater trochanter	1	2.2
Fracture of the acrylic head	2	4.4
Persistent pain (moderate to severe)	13	28.8
Infections	0	

Paracapsular Calcification

Nine patients (20 per cent.) in this series presented roentgenographic evidence of calcification in the soft tissues adjacent to the hip joint (Fig. 2). The areas of calcific density varied from a few millimeters to massive deposits surrounding the entire hip joint. Paracapsular calcification occurred in three cases of postoperative dislocation. It is conceivable that the trauma resulting from the dislocation was a factor in producing this excessive tissue response. However, paracapsular calcification occurred in other patients without apparent cause. In one hip examined at autopsy, a large amount of bone detritus was found within the hip joint and in adjacent areas. It is possible therefore that bone debris left in the wound after molding of the femoral neck may be a causative factor. Paracapsular calcification occurred after all types of surgical exposure used in this

FIG. 2

FIG. 3

Fig. 2: The roentgenogram showed extensive paracapsular calcification eighteen months after operation.

Fig. 3: A roentgenogram made three months after operation revealed protrusion of the stem of an Eicher appliance anterolaterally through the cortex of the femur.

FIG. 4

FIG. 5

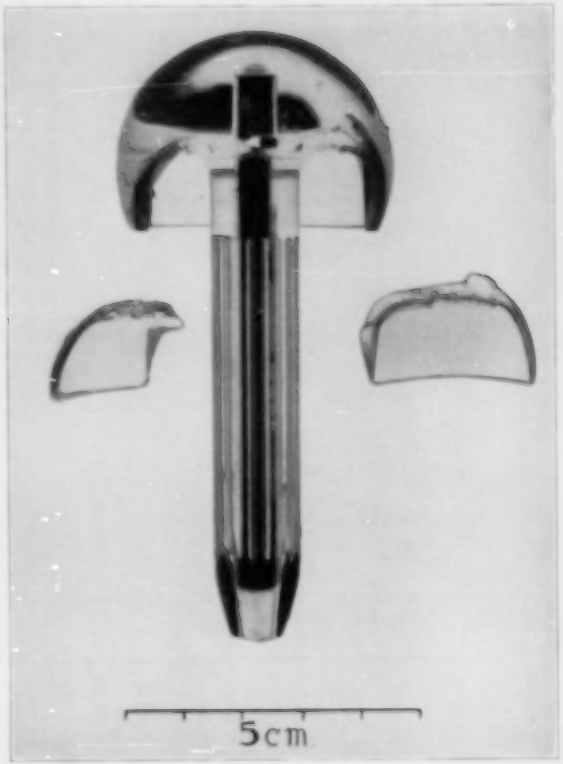

FIG. 6

Fig. 4: Fracture of the proximal third of the femoral shaft had occurred during insertion of the prosthesis.
Fig. 5: Compression fracture of the medial, inferior portion of the femoral neck had occurred during manipulative placement of the Eicher appliance into the acetabulum.
Fig. 6: Showing a fracture of the skirt of the acrylic head discovered at re-operation.

series. As would be anticipated, this complication was associated with an appreciable reduction in the range of hip motion. There was no apparent correlation with postoperative pain.

Pain at the Site of Stem Protrusion

Three patients (7 per cent.) complained of disabling pain at the site of protrusion of the stem from the lateral cortex of the femur. In all cases there was marked tenderness in this area and in one patient, in whom the prosthesis was removed because the head had fractured, a large bursa filled with serosanguineous fluid was found at surgery. The other two patients obtained temporary relief with local infiltration of procaine.

Fractures of the Femur and Stem Protrusion

These complications occurred in the series of five Eicher-replacement arthroplasties. Two patients presented definite roentgenographic evidence of protrusion of the distal portion of the stem through the cortex of the femur (Fig. 3). Both had persistent disabling pain on weight-bearing, but the follow-up studies have been too short to determine the prognostic significance of this complication.

One of these patients sustained a fracture of the proximal third of the shaft of the femur during insertion of the prosthesis (Fig. 4). In the other case, although no fracture occurred, considerable pressure was required to insert the stem of the Eicher prosthesis into the medullary canal.

Fracture of the inferior and medial portion of the neck of the femur occurred in a third patient during surgery when excessive force was required to accomplish reduction (Fig. 5).

FIG. 7

In this patient, a posterosuperior dislocation occurred on the evening after surgery. Reduction was easily accomplished and was maintained by abduction and external rotation of the hip.

Varus Deformity

Varus deformity occurred postoperatively in two cases of Judet arthroplasty (5 per cent.). In one case, the stem of the prosthesis did not penetrate the cortex at the base of the greater trochanter, and within several months a varus deformity became evident. This patient suffered an avulsion of a surgically re-attached greater trochanter during a postoperative examination for range of hip motion. Because of increasing pain, the Judet prosthesis was removed and an Eicher appliance was inserted. This is the unfortunate patient already referred to who had sustained a fracture of the femoral shaft and later protrusion of the stem of the Eicher prosthesis. He is still unable to bear weight on the affected side because of disabling pain.

In the other case, roentgenographic evidence of varus displacement of the prosthesis was not manifested until one year after surgery. During the period immediately after operation there was hematoma formation and subsequent dislocation as described above. Paracapsular calcification and subluxation were additional complications.

Fracture of the Prosthesis

Mechanical accidents involving the Judet prosthesis occurred in three cases. One patient, who had been making satisfactory progress for three months after surgery, sustained an injury to his left hip when he slipped and fell. Following this injury, the patient had pain only on certain motions of the hip and described a "locking" sensation. Surgical exploration of the hip revealed that the head of the prosthesis had fractured into three segments, two of which were imbedded into the synovial tissue.

A second patient, who exhibited the same type of fracture of the prosthesis, complained suddenly of severe pain ten months after the operation. The hip joint was re-explored and a fracture of the skirt of the prosthesis similar to that shown in Figure 6 was found.

Another case of unusual interest, but not included in our statistical survey because the patient was treated in another clinic *, involved a fracture of the stem of the Judet prosthesis. This patient had been walking with crutches when the fractured stem was noted on roentgenograms made six months after the operation.

Persistent Pain

In the final analysis, relief from pain is the most important postoperative consideration. In this series of forty patients, thirteen have complained of persistent pain of a moderate to severe degree three to sixteen months after operation. Four patients operated upon less than three months ago have not been evaluated from a standpoint of pain. Excluding these four patients, this makes a total of 32.5 per cent. of living patients who have had persistent disabling pain. Included, of course, in this group of patients with persistent pain are many described as having one or more complications. Four, however, had no other complications.

SUMMARY

A total of fifty-three complications occurred in twenty-three patients. Different complications were encountered which produced varying degrees of disability. It is appropriate to quote from the conclusions drawn by Judet and Judet [3] from their recent report of 400 patients: "Some fatalities and a proportion of bad or poor results make this operation one to be undertaken only by surgeons well trained in the surgery of the hip and only on patients who really need it". Although our study is not an end-result evaluation, we feel justified in recommending that surgeons have a critical awareness of the many hazards involved in this operation.

REFERENCES

1. Donaldson, J. S.; Sankey, H. S.; and Donaldson, W. F.: Experiences with Hip Prostheses. Surg., Gynec., and Obstet., **95:** 416–422, 1952.
2. Judet, Jean, and Judet, Robert: The Use of an Artificial Femoral Head for Arthroplasty of the Hip Joint. J. Bone and Joint Surg., **32-B:** 166–173, May 1950.
3. Judet, Robert, and Judet, Jean: Technique and Results with the Acrylic Femoral Head Prosthesis. J. Bone and Joint Surg., **34-B:** 173–180, May 1952.
4. MacAusland, W. R.: Replacement of the Femoral Head by a Prosthesis for Reconstruction of the Hip Joint. A Report on the Judet Method. Surg., Gynec., and Obstet., **92:** 513–527, 1951.
5. McBride, E. D.: A Femoral-Head Prosthesis for the Hip Joint. Four Years' Experience and the Results. J. Bone and Joint Surg., **34-A:** 989–996, Oct. 1952.
6. Peterson, L. T.: The Use of a Metallic Femoral Head. J. Bone and Joint Surg., **33-A:** 65–75, Jan. 1951.

* Reported by courtesy of Dr. Morris Zack, Los Angeles, California.

SYME AMPUTATION PERFORMED IN TWO STAGES *

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The Syme amputation, originally performed by Sir James Syme of Edinburgh, in 1843, is the amputation of choice in the lower extremity above the level of a transmetatarsal amputation. The chief advantages as described by Wilson are:

1. It provides a stump capable of transmitting the entire body weight to the ground by direct end pressure without pain;

2. It removes only the foot and, therefore, leaves a stump with the greatest possible leverage power;

3. It is less crippling than the below-the-knee amputation; and there is less feeling of mutilation, because the patient, independent of a prosthesis, can walk about his room on the bare stump.

In the past, in order to produce a Syme stump, it was considered necessary that any infection should be fully quiescent with sterile wound cultures and that the plantar skin should not be involved by any ulceration or draining sinuses prior to surgery. Most writers, including Alldredge, Thompson, Gallie, Wilson, and Irwin, who have had considerable experience with these amputations, describe two criteria essential for the success of the Syme amputation: (1) The skin covering the bottom of the heel must be healthy and undamaged; and (2) sepsis and foul sinuses adjacent to the operative field must be absent in order to prevent contamination of the wound. Slocum, however, does state that by the use of atypical flaps a functional Syme amputation may be obtained when the original injury involves the heel pad.

In the presence of infection and involvement of the plantar skin, departure from these previously established principles can be accomplished by the use of the two-stage operation first described by Hulnick. Many patients with open wounds of the foot and infected sinuses, who might very well have been subjected to an open amputation through the leg, can be offered an effective Syme stump by this method. In the presence of open wounds with active drainage, a partial disarticulation at the ankle, in which the anterior and posterior skin flaps are preserved, is followed by loose closure of the anterior and posterior skin flaps allowing adequate drainage. This will usually heal without extension of the infection into the lower portion of the leg. If the tibia and fibula are not disturbed in the disarticulation at the ankle, osteitis or the spreading of the infection into the distal end of these bones is prevented. Bone bleeding is also prevented, thus a source for formation of hematoma and the spreading of infection is removed. By leaving the anterior and posterior skin flaps redundant and by performing a loose closure, the surgeon ensures adequate drainage and prevents the constriction and embarrassment of the circulation to the skin flaps. Ulceration and draining sinuses involving the plantar skin of the heel have been observed to close and to leave small non-tender scars; thus a heel pad which otherwise would be considered inadequate is preserved. The heel-pad shrinkage which occurs between the first and second stages allows an accurate positioning of the heel pad at the second stage, with the elimination of a redundant or flabby stump. When healing has been obtained and infection has been controlled, the second stage—that of converting the ankle disarticulation into a Syme amputation—is performed.

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Chicago, Illinois, January 28, 1953.

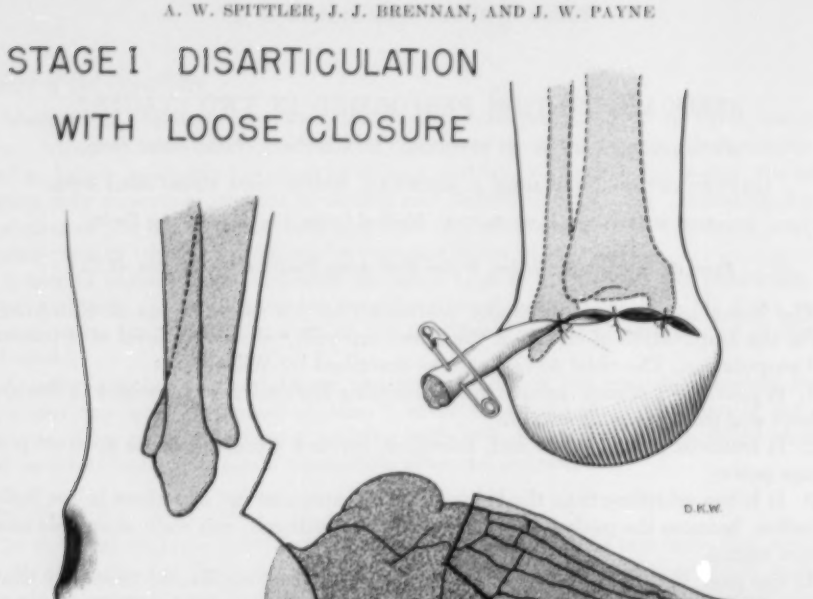

FIG. 1

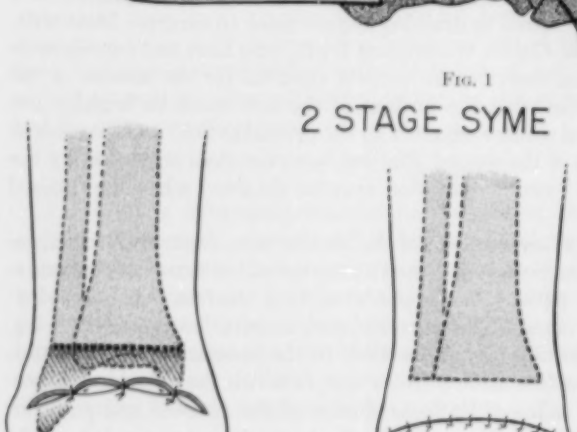

FIG. 2

Fig. 1: Diagram of the first stage of the two-stage Syme amputation procedure shows the incision, the part removed, and the ulcerated area over the heel.

Fig. 2: On the left is shown the completion of the first stage. When the ankle disarticulation is converted into a Syme amputation, the outlined portions of the tibia and fibula will be removed. On the right is shown the completed Syme amputation. Note the ends of the tibia and fibula and the well positioned heel pad.

Thirty-six two-stage Syme amputations have been performed at Walter Reed Army Hospital since 1946. Two patients had the procedure performed on both legs. Seven patients had other types of amputation of the opposite extremity, including two with unmodified Syme amputations. The patients ranged from eighteen to forty years in age. Thirty of them were war casualties of whom twenty-two were from the Korean conflict. Three patients received their injuries in hunting accidents. In one, the procedure was done in treatment of a condition resulting from Buerger's disease. All patients had active infection at the time of the first stage of the surgical procedure. Osteomyelitis, involving the injured foot, was present in twenty-four patients and was producing active drainage with positive bacteriological findings. Wet gangrene was present in twelve patients, eight cases of which were the result of frostbite. Involvement of the plantar skin, either directly with ulceration involving the heel pad, or

indirectly with ulceration of the adjacent skin around the malleoli and draining sinus tracts involving the heel, was present in twenty-five patients.

Twenty-seven of the patients had had numerous surgical procedures, including partial amputations of the foot, sequestrectomies, and skin grafts, prior to admission for the first stage of the procedure. The first stage of the surgical procedure was performed from one to sixty-eight months after injury. If eight chronic long-term patients are omitted, the average interval of time from injury to amputation was 2.8 months.

Preoperatively, all patients were treated with adequate doses of the antibiotics indicated by bacteriological studies. Enzymatic débridement was used when indicated and hastened the time of the initial surgery.

The time interval between the first stage and the second stage of the procedure ranged from three to thirty-six weeks. If three patients whose operation was delayed because of treatment for other injuries are not included, the average time between stages was seven weeks.

TECHNIQUE

Stage I: Disarticulation of the Ankle (Fig. 1)

Preoperative preparation of the extremity consists in repeated scrubbings with a hexachlorophene soap. A tourniquet is applied at the time of surgery in order to obtain a bloodless field. Whenever possible, the usual skin incisions for the Syme amputation are modified in order to retain longer anterior and posterior skin flaps. These vary with the viable skin still present on the foot as the flaps must be made of viable skin and subcutaneous tissue. The anterior flap is retracted by subfascial dissection to the ankle joint and the ankle joint is entered by the severing of all tendons, nerves, vessels, and the anterior capsule at the level of the anterior joint line. On the medial side, the deltoid and the talotibial ligaments are severed with a sharp scalpal, the cutting edge being directed toward the tarsal bones. The calcaneofibular and talofibular ligaments are severed in a similar manner on the lateral side. After the posterior capsule has been cut, the talus and calcaneus are rotated forward with the aid of a bone hook to expose the tendo achillis which is divided near its insertion into the calcaneus. The calcaneus is freed by sharp extraperiosteal dissection, the surgeon being careful to guard the posterior tibial artery, vein, and nerve. The freed calcaneus is elevated and completely removed from the posterior flap together with the short muscles and plantar fascia attached to it. The posterior tibial, flexor hallucis longus, and flexor digitorum communis tendons are cut where encountered without traction in order to minimize tendon-sheath infection. The posterior tibial nerve is not dissected out at this time, but is severed when it is encountered. The tibia and fibula are not disturbed or resected. The tourniquet is released and hemostasis is obtained prior to closure. Because of the possibility of jeopardizing the posterior skin flap, no attempt is made to trim the redundant skin or the corners of the flaps. Closure is accomplished with four or five interrupted sutures of stainless-steel wire through all layers and a rubber-dam drain is inserted to emerge from the lateral aspect of the incision. After the heel pad has been positioned centrally over the articular surface of the tibia, a compression dressing is applied.

Postoperatively the extremity is kept elevated until the reactive oedema has subsided. Antibiotic therapy, based upon the preoperative bacteriological studies, is continued. The wound is first dressed in forty-eight hours and as often thereafter as the dressing becomes saturated. The drain is removed from two to seven days postoperatively, depending upon the severity of infection and the amount of drainage. The position of the heel pad is maintained by accurately applied dressings. When drainage ceases, a snug positional plaster-of-Paris boot is applied and the patient is made ambulatory, with partial weight-bearing progressing to complete weight-bearing.

Stage II: Conversion of the Ankle Disarticulation to the Syme Amputation (Fig. 2)

Preoperative preparation with hexachlorophene-soap scrubbings is again performed, preferably for several days. A tourniquet is applied at the time of surgery. The old operative cicatrix is excised, the distal portions of the tibia and fibula are exposed extraperiosteally, and the heel pad is separated from the articular surface of the tibia. The medial and lateral malleoli are sawed off at right angles to the weight-bearing surfaces, but the articular cartilage is left on the end of the tibia. Excessive cicatricial tissue in the periosteal flap is carefully excised. The posterior tibial nerve is identified and cut back to the level of the tibial margin. The posterior tibial, flexor hallucis longus, and flexor digitorum communis tendons are pulled down, severed, and allowed to retract. The sural and superficial peroneal nerves are identified in the subcutaneous tissue, are cut sharply, and

FIG. 3

Fig. 3: The heeled stumps produced by the second stage of the procedure in a bilateral amputee.

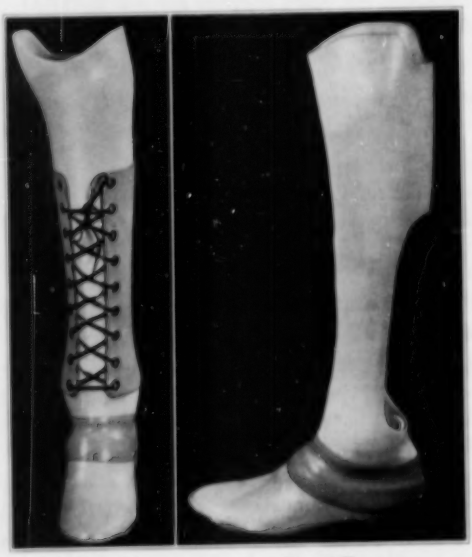

FIG. 4-A FIG. 4-B

Figs. 4-A and 4-B: Anterior and lateral views of the Syme prosthesis of laminated plastic.

are allowed to retract. The posterior tibial artery is protected to ensure good blood supply to the posterior flap. The subcutaneous layer of the posterior flap is beveled to prevent redundancy and the anterior flaps are cut back to produce a neat plastic closure. The tourniquet is removed and complete hemostasis is obtained. The skin flaps are approximated accurately with subcutaneous and skin sutures. A drain is used if absolute hemostasis is not present. It is removed in forty-eight hours.

A compression bandage is applied to fit firmly and to position accurately the heel pad over the distal tibial surface. Positioning is an important part of the postoperative care to make the stump suitable for weight-bearing. The dressings are carefully changed and are rewrapped frequently in the first three weeks to prevent medial shift of the heel pad. Shrinkage is then continued in a plantar boot accurately applied to maintain position of the heel pad. Four weeks later the stump is ready for fitting with a prosthesis (Fig. 3). The average Syme amputee requires only three to five days of training in walking with his prosthesis.

PROSTHESIS

The first few patients were fitted with a Syme prosthesis, consisting of the willow foot with the posterior portion made shallow to accommodate the stump and the single-bolt ankle assembly, allowing anterior and posterior motion. The stump socket was formed of molded leather, open anteriorly to allow insertion of the stump, and closed by lacing with

a leather thong. This was attached to a heavy steel frame, containing the ankle base distally and extending up the medial and lateral aspects of the socket. The majority of the patients were later fitted with a strong, light, laminated plastic molded socket (Figs. 4-A and 4-B). The plastic socket which was molded to the leg was of two types. In the first type the anterior portion was cut away to allow insertion of the stump and was made snug by lacing the opening with a leather cuff. The second type had a portion of the posterior plastic socket removed to allow insertion of the stump and was firmly fitted with a laced leather cuff. A four-way ankle assembly which requires more space may be used in the bilateral Syme amputee for whom leg lengths can be equalized in the prosthesis. This allows the patient anterior, posterior, and lateral motion of the ankle.

RESULTS

Thirty-six two-stage Syme amputations have been performed and prostheses have been fitted to the stumps at Walter Reed Army Hospital since 1946. Two of these were bilateral. Thirty patients are able to use their prostheses a full day in performing their routine tasks. Sixteen are doing manual labor and four have returned to military duty. The average follow-up has been one year and six months; the longest is five years and four months. Two were subjected to higher amputations because of bone loss and uncontrolled osteomyelitis in the upper portion of the leg. Their Syme stumps were, however, satisfactory at the time of the higher amputation. One patient was subjected to a thigh amputation because of causalgia and an anaesthetic stump after failure of response to neurolysis of the injured peroneal and posterior tibial nerves in the popliteal space. In one patient in this series who had had an injury to the distal portions of the tibia and fibula with partial loss of the malleoli, the ankle disarticulation healed so well following the first stage that the second stage was not performed. This patient was fitted with a prosthesis and has been using his stump for three years.

COMPLICATIONS

Complications to the present time have consisted of three superficial peroneal-nerve neuromata which were removed surgically and which have caused no further difficulty. Thrombophlebitis, which developed in one patient postoperatively, responded to therapy with anticoagulants and antibiotics.

CONCLUSIONS

Syme amputations, done in two stages, can be accomplished in the presence of open wounds and infected draining extremities which otherwise would have been subjected to higher open amputations. Patients with a Syme stump have been fitted with a light but strong plastic prosthesis, and have developed excellent gait with stumps capable of bearing the entire body weight without pain.

REFERENCES

1. Alldredge, R. H.: The Management of War Amputations in General Hospital. New York State Med. J., **44:** 1763–1770, 1944.
2. Alldredge, R. H.: Major Amputations. Surg., Gynec., and Obstet., **84:** 759–764, 1947.
3. Alldredge, R. H., and Thompson, T. C.: Technique of the Syme Amputation. J. Bone and Joint Surg., **28:** 415–426, July 1946.
4. Craft, A. W. J.: Amputations, Limb Fitting and Artificial Limbs. Ann. Roy. Coll. Surg. of England, **5:** 190–207, 1949.
5. Gallie, W. E.: The Experience of the Canadian Army and Pensions Board with Amputations of the Lower Extremity. Ann. Surg., **113:** 925–931, 1941.
6. Harris, R. I.: Amputations. J. Bone and Joint Surg., **26:** 626–634, Oct. 1944.
7. Hulnick, Alvin: Personal communication (1946).
8. Hulnick, Alvin; Highsmith, Charles; and Boutin, F. J.: Amputations for Failure in Reconstructive Surgery. J. Bone and Joint Surg., **31-A:** 639–649, July 1949.

9. Irwin, S. T.: The End Results in Partial Amputations of the Foot. British J. Surg., **7**: 327–334, 1919–1920.
10. Kirk, N. T.: Amputations. *In* Lewis' Practice of Surgery, Vol. 3. Hagerstown, Maryland, W. F. Prior Co., Inc., 1948.
11. McKeever, F. M.: A Discussion of Controversial Points in Amputation Surgery. Surg., Gynec., and Obstet., **82**: 495–511, 1946.
12. McKeever, F. M.: Injuries of the Forefoot. *In* Instructional Course Lectures, The American Academy of Orthopaedic Surgeons, Vol. VI, pages 120–129, 1949. Ann Arbor, J. W. Edwards, 1949.
13. Slocum, D. B.: An Atlas of Amputations. St. Louis, The C. V. Mosby Co., 1949.
14. Spittler, A. W., and Brennan, J. J.: Lower Extremity Amputations. Southern Med. J., **45**: 942–946, 1952.
15. Spittler, A. W., and Taylor, L. W.: Causes for Amputations Performed at Walter Reed General Hospital in the Years 1947–1948. J. Bone and Joint Surg., **31-A**: 800–804, Oct. 1949.
16. Syme, James: Surgical Cases and Observations; Amputations at the Ankle Joint. The London and Edinburgh Monthly J. Med. Science, **26**: 93–96, 1843.
17. Thomas, Athia, and Hadden, C. C.: Amputation Prosthesis. Philadelphia, J. B. Lippincott Co., 1945.
18. Wilson, P. D.: The Syme Amputation. Surg. Clin. North America, **1**: 711–728, 1921.

DISCUSSION

Dr. Athia Thomas, Denver, Colorado: The value of the Syme amputation has been a point of controversy in surgical literature for many years. The British limb-fitting surgeons at the amputation center at Roehampton, on the basis of a wide experience following World War I, have almost universally condemned its use. On the other hand, Canadian authorities have used it widely and have defended its use vigorously.

Although its value in selected cases is admitted, there have been certain definite and well recognized contra-indications which heretofore have limited its usefulness. Foremost among these were infection, sloughing skin, and ulceration involving the plantar flap or the area adjacent thereto. It would appear from the procedure just described that these formidable hazards have been overcome.

Another condition which has always been considered a contra-indication to the Syme amputation is that of impaired circulation. I note that the authors report a patient with Buerger's disease who was successfully subjected to the procedure. I am not sure that I would have the temerity to carry out such a procedure in the presence of peripheral vascular disease. I have seen some rather tragic results when it has been attempted.

Another definite objection to the Syme amputation is a cosmetic one. The stump is long and bulbous, and the prosthesis is heavy and unsightly. The new type of prosthesis constructed of plastic laminate with a flexible ankle joint and wooden foot just described by the authors overcomes some of these objections. It is light, durable, and not so lengthy as the old conventional type. Nevertheless, the operation, in my opinion, should not be done in a woman because of cosmetic objections.

One final word of caution should be uttered in recommending the Syme amputation. Meticulous and skillful surgery and aftercare are essential for its success; and the operation, in my opinion, should not be attempted by the occasional surgeon who performs so many of the amputations in civilian practice in this country.

In conclusion, I wish to commend the authors for presenting a procedure which I believe is a distinct advancement in amputation surgery and which broadens the usefulness of a valuable amputation which heretofore has had certain definite limitations.

Dr. Alvin Hulnick, Staten Island, New York: The operation was originally devised in an attempt to find a procedure similar to the open amputation or modified guillotine which has proved so successful in the leg and thigh. An open amputation of the mid-tarsal joint leaves a bone area of at least two or three inches which must be covered. This can be done only by skin-grafting which takes many months and which is just as impractical in this amputation as it is in others. It is obviously impossible to put traction on the plantar skin and to expect it to pull down and cover the bone. In many of the feet subjected to an amputation in the mid-tarsal region, the infection had already spread to the soft cancellous bone of the calcaneus or had spread into the subtalar joint. Numerous patients were seen who had been treated for many months and even years in an attempt to control and cure the infection; finally the foot had to be sacrificed and a below-the-knee amputation had to be done.

Originally a circular incision was made at about the level of the mid-tarsal joint, through which the calcaneous was removed. This allowed the plantar skin to be brought forward and sutured loosely to the dorsal skin. Both corners of the wound were left widely open to allow drainage. By leaving the talus intact, we hoped to keep infection out of the ankle joint. Some patients were so pleased with the intermediate stage that they hesitated to have the final stage done.

I agree with Colonel Spittler that it is advisable to obtain a Syme stump if it is at all possible. The two-stage procedure seems to give a higher percentage of good stumps than the one-stage procedure done on

(*Continued on page 56*)

AN EVALUATION OF FEMORAL SHORTENING WITH INTRAMEDULLARY NAILING*

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From the Hospital for Special Surgery, New York

Assurance of healing without complication is of primary importance when elective surgery is performed on the normal extremity. There is, therefore, an obvious necessity for a dependable method of femoral shortening in persons with unequal limb length. In our opinion, the ideal technique must include minimal operative trauma, accurate and permanent correction of limb length, secure fixation, and assured healing. Early ambulation is desirable, but it is not a prime consideration.

In a previous paper from the Hospital for Special Surgery, the results of femoral shortening by means of oblique osteotomy and screw fixation in eighteen patients were reported. Since 1944, an additional twenty-two patients have had femoral shortening done by this type of operation. Femoral shortening has been carried out in eleven other patients by means of transverse osteotomy and intramedullary-nail fixation. The appearance of a relatively high number of complications in this latter group of patients has stimulated this review. We are not at this time concerned with other methods of limb-length equalization.

HISTORY OF FEMORAL SHORTENING

Howorth, in 1942, provided an excellent survey of the literature on this subject: Femoral shortening with overriding of the fragments was done as early as 1847 by Rizzoli, and by Mayer in 1850 and Sayre in 1863. Metallic internal fixation was described in femoral-shortening operations by Deutschländer in 1907 who used aluminum plates and screws. Shands, in 1917, employed wire sutures; Fassett, in 1918, described the use of a Lane plate; and Royle, in 1923, reported four resections in which intramedullary pegs were used and one in which a Lane plate was employed. In 1916, Taylor reported cadaver experiments to gain shortening by mortising operations, with fixation achieved by the use of plates, intramedullary pegs, and transfixion pegs. Calvé, in 1918, described three methods of fixing the femoral fragment by tenon and mortise. Further experience with this was reported in 1931 by Hey Groves, and in 1933 by Moore and Camera.

Howorth described experiences in femoral-shortening operations at the New York Orthopaedic Dispensary and Hospital from 1928 to 1940. Angulation or separation occurred in patients who had been treated with the step-cut osteotomy even when an intramedullary bone peg was employed. When secure internal fixation by a metallic plate and screws which engaged both cortices was added to the method, success was achieved.

The method of femoral shortening by means of the oblique osteotomy was reported by White in 1935 and in 1944. He opposed the step-cut osteotomy because of the loss of bone strength. He reported 100 cases in which the oblique osteotomy had been used; there were no instances of non-union or delayed union.

Femoral shortening by the use of a supracondylar transverse osteotomy was presented by R. D. Moore in 1947. The excised bone segment was divided into three grafts — one for intramedullary insertion and two for onlay transplants. The supracondylar location was preferred because of the assurance of prompt healing.

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Chicago, Illinois, January 28, 1953.

FEMORAL-SHORTENING OPERATIONS AT THE HOSPITAL FOR SPECIAL SURGERY, 1938 TO 1952

Fifty-one femoral-shortening procedures were done at the Hospital for Special Surgery in the period 1938 to 1952; forty of these were by means of an oblique osteotomy. There have been eleven cases of shortening by the use of a transverse osteotomy and fixation with a Küntscher intramedullary nail. Of the nineteen cases of femoral shortening by oblique osteotomy which were reported in 1944, all but the first patient had fixation by metallic screws (Fig. 1).

OBLIQUE OSTEOTOMY

Operative Technique of Oblique Osteotomy

According to the technique of Henry, the femur is exposed through a long anterolateral thigh incision. After separation of the vastus lateralis and rectus femoris, the vastus intermedius is divided longitudinally to the bone which is exposed subperiosteally. The amount to be shortened is marked transversely on the femur with an osteotome. The oblique osteotomy is so planned that the spike of the proximal fragment will project laterally. The line of osteotomy in a long oblique plane is marked with frequent drill holes. The entire middle third of the femur should be used in order to ensure adequate strength of the final fixation. This length provides abundant healing surface. The osteotomy is completed with the osteotome. The distal and proximal spikes are then overlapped until the transverse marks of the desired shortening are in line. The protruding ends of the spikes are removed. While the fragments are held in the desired position with the fracture clamp, they are fixed with transverse screws, four in number, which are placed in staggered relationship to each other. Fixation *must* be secure. Postoperatively, either a single plaster spica or balanced suspension in a Thomas splint is employed.

Postoperative Management after Oblique Osteotomy

If the patient has been immobilized in a plaster cast, it is removed at six to eight weeks postoperatively to allow for the beginning of active knee exercises. Walking with crutches with minimal weight-bearing may be allowed at eight to ten weeks. Crutches are discarded when the osteotomy is secure as shown by roentgenograms. In those patients who are treated by balanced suspension in a Thomas splint with a Pearson attachment, early active and assisted exercises for the knee, hip, and foot are possible. This support is continued for six to eight weeks, when walking with crutch support is allowed.

Complications of Femoral Shortening by Oblique Osteotomy

There were five complications in the total of forty patients presented in this series. Three of these have been previously listed among the eighteen patients reported in 1944.

CASE 1. C. L., a girl, nineteen years of age, had suffered from osteomyelitis of both hips with a resulting limb-length discrepancy of 5 centimeters. The normal femur was shortened 4.5 centimeters by means of an oblique osteotomy through an area of old infection on June 19, 1940. Postoperatively there was wound infection with a sinus tract. One year later it was necessary to remove the screws and to excise the sinus; healing resulted.

This patient, known to be a risk, demonstrates the danger of operating through an area of old osteomyelitis.

CASE 2. B. C., a boy, fourteen years old, had had fibrous dysplasia of bone with a resulting limb-length discrepancy of 6.3 centimeters. The normal femur was shortened 5.6 centimeters by means of an oblique osteotomy on December 19, 1943. Postoperatively, there was superficial wound infection; this was well healed three months later after the wound had been opened widely.

FIG. 1

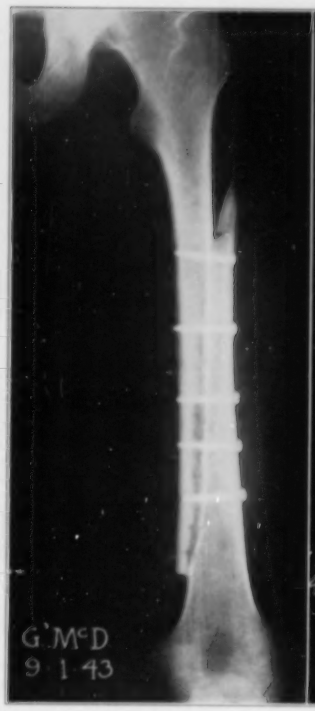

FIG. 2-A

FIG. 2-B

Fig. 1: K. K., a woman, thirty years old, had a limb-length discrepancy of 6.3 centimeters resulting from poliomyelitis. The femur of the normal extremity was shortened 5 centimeters by oblique osteotomy on February 1, 1946. Note length of the osteotomy and the solidity of bony union as shown in this roentgenogram made ten weeks after the operation.

Figs. 2-A and 2-B: G. McD. Postoperative roentgenograms made two (Fig. 2-A) and seven (Fig. 2-B) months after the operation. In Fig. 2-B, note the bony prominence arising from the distal tip of the proximal osteotomy spike which interfered with function of the vastus medialis. This was removed.

This case is an example of definite postoperative wound infection.

CASE 3. G. McD., a woman, forty-one years old, had had a congenitally dislocated right hip with a resulting limb-length discrepancy of 6.3 centimeters. The left femur was shortened 5.6 centimeters by means of an oblique osteotomy on July 6, 1943. Postoperatively there was stiffness at the knee; this disappeared after the medial spike had been trimmed (Figs. 2-A and 2-B).

The complication in this patient proves the desirability of placing the spike of the proximal fragment on the lateral aspect of the femur in its final position, so that involvement of the vastus medialis is avoided. The value of the removal of the projecting spike where it does not add to stability is also shown.

In the additional twenty-two patients operated upon since the report of 1944, there have been two additional complications:

CASE 4. J. J., a girl, fourteen years old, had suffered osteomyelitis with a resulting limb-length discrepancy of 5 centimeters. The normal femur was shortened 4.5 centimeters by means of an oblique osteotomy on June 11, 1949. Postoperatively, there was fracture of the osteotomy spike; this did not delay union.

This is an example of an unavoidable operative complication.

CASE 5. E. E., a woman, thirty-two years old, had had a congenitally dislocated hip with a resulting limb-length discrepancy of 5.6 centimeters. The femur of the uninvolved extremity was shortened 5 centimeters

FIG. 3-A FIG. 3-B FIG. 3-C

Fig. 3-A: E. E., a woman, thirty-two years old, had a limb-length discrepancy of 5.6 centimeters resulting from congenital dislocation of the hip. On December 19, 1951, the femur of the uninvolved extremity was shortened 5 centimeters.

Fig. 3-B: In the third week after the operation, the proximal osteotomy spike and a screw fractured.

Fig. 3-C: A roentgenogram made on May 13, 1952, revealed solid healing.

by an oblique osteotomy on December 19, 1951. Postoperatively, while the extremity was in sling suspension because of fracture at the base of the proximal spike and the breaking of the uppermost screw, angulation of osteotomy developed. Closed reduction and the treatment by immobilization in a hip spica for eight weeks resulted in solid union (Figs. 3-A, 3-B, and 3-C).

In retrospect, it was felt that the osteotomy was too short and that this obese patient would have been better treated by immobilization in a spica.

FEMORAL SHORTENING BY TRANSVERSE OSTEOTOMY AND INTRAMEDULLARY KÜNTSCHER-NAIL FIXATION

In the three years from 1948 through 1951, there were eleven patients treated by the technique of transverse osteotomy with Küntscher-nail fixation.

Operative Technique

The femur is approached through an anterolateral Henry incision in the upper mid-shaft. After the interval between the rectus femoris and vastus lateralis has been passed through, the fibers of the vastus intermedius are divided longitudinally and the femur is exposed subperiosteally. The desired amount of shortening is marked transversely on the femoral shaft. The drilling of these sites is done before resection of the intervening fragment with an osteotomy. The Küntscher-nail guide is driven retrograde into the proximal fragment of the femur, the thigh being held in adduction. A small skin incision is made at the point where the guide emerges in the supratrochanteric area. Great care must be exerted in the selecting of the proper Küntscher nail as to both length and diameter. As the osteotomy is done at the narrowest portion of the intramedullary canal, the nail selected should be checked for size at the site of osteotomy. If the fit of the nail is too tight,

the intramedullary space can be reamed with a special instrument just above and just below the osteotomy level. (When it is in its final position, the nail should reach the intercondylar space, but it should remain about one inch proximal to the knee joint, and from one-half to one inch of the length of the nail should appear above the greater trochanter.) The selected nail is driven from above over the guide and down the proximal fragment of the femur. As it emerges at the osteotomy site, the guide is removed and the distal fragment is aligned both longitudinally and in rotation with the proximal fragment. The nail is then driven down the distal fragment of the femur until only one-half to an inch of its length remains above the trochanter. The position of the nail above the knee joint should be checked by x-ray in the operating room. In order to avoid separation at the osteotomy site, a special plate with lugs which was devised by one of us (T. C. T.) may be fitted into drill holes on either side of the osteotomy while the nail is being inserted. Should there be a sliding of either fragment on the nail at this point, a staple can be driven firmly through drill holes, care being taken to avoid the nail, in order to prevent further separation. The fragment of the bone removed in doing the osteotomy may be cut into small longitudinal segments, may be placed about the osteotomy site, and may be fastened there with circumferential sutures.

Postoperative Management

Early weight-bearing is encouraged, at first with crutches. It is wise to apply elastic bandages to the entire extremity in the early period of walking. The nail is removed after union is definite as shown by roentgenogram. Although early ambulation is encouraged, firm union takes nine to twelve months.

Because of their individual interest, case histories are presented for all of the patients treated by this method.

CASE 1. J. B., a woman, twenty-nine years old, had had congenital dislocation of the hip with a resulting limb-length discrepancy of 4.7 centimeters. On February 16, 1948, the femur of the uninvolved extremity was shortened 2.5 centimeters by means of the Leveuf reconstruction procedure with Küntscher-nail fixation. Redislocation of this hip required open reduction two and one-half weeks later. The patient was immobilized in a spica for ten weeks because of acute postoperative psychosis which required shock therapy. She was ambulatory at three months. There was a bony bridge at the osteotomy site at four months, and the nail was removed at ten months.

CASE 2. T. Mc., a man, twenty-seven years old, had had osteomyelitis with a resulting limb-length discrepancy of 10 centimeters. On April 24, 1948, the uninvolved femur was shortened 8.1 centimeters by means of a transverse osteotomy with fixation brought about through the use of a Küntscher nail and two staples. He was treated in sling suspension for three and a half weeks. Genu recurvatum of 30 degrees developed; this disappeared five months after the operation. By that time there was solid callus. The nail was removed one year after the procedure.

CASE 3. V. S., a woman, thirty-five years old, had suffered bilateral congenital dislocation of the hip with a resulting limb-length discrepancy of 4.4 centimeters. On January 6, 1949, the longer extremity was shortened 4.1 centimeters by a transverse osteotomy of the femur with Küntscher-nail fixation. At the same time a shelf stabilization of the hip was performed. The patient was immobilized in a spica for six weeks. Clinical union was obtained by ten weeks; crutches were discarded four months after the operation; solid callus was present eight months after the procedure; and the nail was removed one year after the operation.

CASE 4. J. X., a woman, nineteen years old, had a limb-length discrepancy of 4.4 centimeters after poliomyelitis. On February 4, 1949, the longer extremity was shortened 3.8 centimeters by a transverse osteotomy of the femur with Küntscher-nail fixation. During the procedure, fragmentation at the osteotomy site prevented close apposition. Ambulation was allowed one week after the operation; crutches were discarded at four months; there was solid union by seven months; and the nail was removed eight months after the operation (Figs. 4-A and 4-B).

CASE 5. S. Van H., a boy, sixteen years old, had a limb-length discrepancy of 4.4 centimeters after poliomyelitis. On June 20, 1949, the femur of the longer extremity was shortened 3.1 centimeters by means of a transverse osteotomy with Küntscher-nail fixation. During the operation it was found that impaction of the osteotomy site was impossible because of a tightly fitting nail. The patient was returned to the ward with a gap of 3.8 centimeters. One week later, this gap was closed by impaction of the proximal portion of

FIG. 4-A FIG. 4-B

FIG. 5-A FIG. 5-B

Figs. 4-A and 4-B: J. X. Roentgenograms made three days (Fig. 4-A) and eight months (Fig. 4-B) after the operation. Note fragmentation at osteotomy site, which, as Fig. 4-B shows, eventually healed.

Fig. 5-A: S. Van H. Roentgenogram made five days after the first operation shows the separation of the fragments by the impacted nail. This required a secondary operation in order to effect closure.

Fig. 5-B: Roentgenogram made eight months after the secondary operation.

the femur on the distal portion; the excess nail above the greater trochanter was removed. The patient became ambulatory on the first postoperative day. Postoperatively there was genu recurvatum of 10 degrees with limitation of active extension for two months. The patient discarded his crutches two weeks after the operation; there was abundant callus at three weeks; union was solid at two months; and the nail was removed eight months after the operation (Figs. 5-A and 5-B).

CASE 6. E. S., a woman, thirty-three years old, had suffered tuberculosis with a resulting limb-length discrepancy of 6.9 centimeters. On December 3, 1949, the uninvolved femur was shortened 5 centimeters by a transverse osteotomy with Küntscher-nail fixation. The patient was ambulatory two weeks after the operation. There was slight genu recurvatum and loss of full active extension for two months, at the end of which time she discarded her crutches. When the nail was removed ten months after the operation because of sciatic-nerve irritation, there was solid callus (Figs. 6-A and 6-B).

CASE 7. W. L., a woman, forty-one years old, had suffered congenital dislocation of the hip with a resulting limb-length discrepancy of 5 centimeters. On January 7, 1950, the uninvolved femur was shortened 3.8 centimeters by a transverse osteotomy with Küntscher-nail fixation. One month after this procedure, the patient was re-operated upon for the replacing of a bent nail; seven months later the distal one half of the second nail was removed and a new nail was inserted. At this time, onlay bank-bone grafts were applied. The patient was ambulatory on the second postoperative day after each operation; she discarded her crutches within two weeks. Because of non-union, persisting for twenty-three months, all intramedullary fixation was removed in December 1951, and inlay and onlay iliac-bone grafts were applied. The patient was immobilized in a spica for four months. There was abundant callus formation early. Solid healing was obtained seven months after the last procedure, at which time crutches were abandoned (Figs. 7-A, 7-B, and 7-C).

FIG. 6-A FIG. 6-B

Figs. 6-A and 6-B: E. S. Roentgenograms made three weeks (Fig. 6-A) and six months (Fig. 6-B) after the operation. Although the result was technically satisfactory in this patient, sciatic-nerve irritation developed which required the removal of the nail.

CASE 8. M. A., a woman, nineteen years old, had had tuberculosis with a resulting limb-length discrepancy of 6.9 centimeters. On April 3, 1950, the uninvolved femur was shortened 6.3 centimeters by a transverse osteotomy with Küntscher-nail fixation. She was ambulatory on the second postoperative day; slight genu recurvatum disappeared one month after the operation; crutches were discarded six weeks after the operation; there was solid callus two months after the operation.

CASE 9. S. V., a girl, sixteen years old, had had a congenitally dislocated hip treated by a Hass osteotomy in October 1950. A limb-length discrepancy of 5 centimeters resulted. The femur of the normal limb was shortened 3.8 centimeters by a transverse osteotomy with Küntscher-nail fixation on December 10, 1950. Ambulation without crutches was allowed three weeks after the operation. In spite of moderately dense callus formation, the nail broke and acute angulation occurred five and one-half months after the operation. At re-operation on July 2, 1951, a second nail was inserted, together with the application of onlay bank-bone grafts. Ambulation was allowed on the first postoperative day, and crutches were discarded six weeks after the operation. Secure bony union was delayed until eight months after the operation. The nail was removed twenty-three months after the original procedure. At twenty-four months there was still 15 degrees of genu recurvatum (Figs. 8-A, 8-B, and 8-C).

FIG. 7-A

FIG. 7-B

FIG. 7-C

Fig. 7-A: W. L. Roentgenogram made one month after femoral shortening shows angulation of the nail.

Fig. 7-B: Roentgenogram made twenty-three months after the original procedure shows non-union. This had persisted in spite of the replacing of the bent nail. Seven months after the replacing of the bent nail, a third nail was inserted, the proximal half of the second nail being retained as a filler. At this time onlay bone-bank grafts were applied.

Fig. 7-C: Solid bony union was shown by roentgenogram seven months after the removal of intramedullary fixation and the application of inlay and onlay autogenous iliac grafts. The patient was immobilized in a spica.

CASE 10. C. M., a woman, nineteen years old, had a limb-length discrepancy of 7.5 centimeters after poliomyelitis. The uninvolved limb was shortened 6.9 centimeters by a transverse osteotomy with Küntscher-nail fixation. After the patient had been treated in sling suspension for twelve days, ambulation was allowed. Following this, "trombone" action of the femur on the nail with separation at the osteotomy site of 3.8 centimeters occurred, and a large thigh hematoma developed. At re-operation four weeks after the original procedure, the hematoma was incised and drained of 500 cubic centimeters of fluid hematoma. The callus-lined walls of the hematoma were partially collapsed; the osteotomy fragments were approximated and were secured with two staples. A culture of the material obtained when the hematoma was incised was sterile. The wound healed promptly. Ambulation was allowed one month after the second procedure, at which time extensive callus was noticed. The patient discarded crutches at six weeks. Genu recurvatum and weakness of the last 30 degrees of extension were present for six months after the procedure (Figs. 9-A, 9-B, and 9-C).

CASE 11. Z. F., a man, twenty-one years old, had a limb-length discrepancy of 5 centimeters after poliomyelitis. The longer extremity was shortened 4.4 centimeters by a transverse osteotomy of the femur with Küntscher-nail fixation. He was allowed ambulation two weeks after the operation. There was adequate callus at one month. The patient discarded his crutches two months after the operation.

DISCUSSION

When the two groups of patients were compared, there was found to be no great discrepancy in age, sex, diagnosis, and amount of shortening obtained (Table I).

Secondary Operations

It was found that there was greater need for secondary operations in the series of patients who were treated by transverse osteotomy with Küntscher-nail fixation (Table II).

TABLE I

FIFTY-ONE FEMORAL SHORTENINGS

1938–1952

	Oblique Osteotomy and Screw Fixation	Transverse Osteotomy and Küntscher-Nail Fixation
Sex		
Male	15	3
Female	25	8
Age		
Youngest	12	16
Oldest	45	41
Average	21	17
Cause of unequal limb length		
Poliomyelitis	17	4
Osteomyelitis	8	1
Congenital shortening	4	
Tuberculosis		2
Congenital dislocation of the hip	3	4
Shortening attained		
Least	2.5 centimeters	2.5 centimeters
Most	7.6 centimeters	8.2 centimeters
Average	5.1 centimeters	5.1 centimeters

Only three secondary operations were required in the group of forty patients who were treated by oblique osteotomy; two of these were because of infection. One of these patients was known to be a risk.

Twelve secondary operations were needed in the eleven patients in whom the Künt-

TABLE II

COMPLICATIONS

	Oblique Osteotomy and Screw Fixation	Transverse Osteotomy and Küntscher-Nail Fixation
Number of operations	40 primary 3 secondary	11 primary 12 secondary
Operative complications	1 in 40 patients In 1, fracture of part of osteotomy spike.	5 in 11 patients In 3, wedged nail. In 2, loose-fitting nail.
Postoperative complications	4 in 40 patients In 1, infection of soft tissue. In 1, flare-up of chronic osteomyelitis. In 1, vastus medialis bursitis. In 1, angulation after breaking of screw.	14 in 11 patients In 5, supratrochanteric pain. In 1, sciatic palsy. In 1, bent nail. In 1, broken nail. In 4, genu recurvatum for 1 to 5 months. (In 1 of these, genu recurvatum was present for 2 years.) In 1, loss of full active extension for 6 months. In 1, non-union.

FIG. 8-A FIG. 8-B FIG. 8-C

Fig. 8-A: S. V. Roentgenogram made seven weeks after femoral shortening.
Fig. 8-B: Fracture of the nail occurred six months after the operation with angulation at the osteotomy site, despite the moderately advanced peripheral callus.
Fig. 8-C: Roentgenogram shows the end result, one year and a half after the replacement of the nail.

scher nail was used after the transverse osteotomy. Even enthusiastic proponents of intramedullary-nail fixation recommend removal of the Küntscher nail after bone healing. In our series, the nail has been removed from seven patients. Each operation is an additional inconvenience and a possible risk to the patient.

Operative Complications

In the series of patients treated by oblique osteotomy, there was only one complication during operation. This was a fracture of a part of an osteotomy spike which in no way interfered with bone healing.

In the series of patients who had had femoral shortening done by transverse osteotomy with Küntscher-nail fixation, there were five operative complications. In three, the fit of the nail was too tight; while in two, it was too loose. Fragmentation of the osteotomy site occurred in one patient (Case 4, J. X.). This was regarded as unfortunate because of the possibility that it might result in more shortening than had been anticipated. In this same patient, the nail became wedged in the distal fragment; this left an excessively long piece of nail protruding above the greater trochanter. In another patient with nail impaction (Case 9, S. V.), the nail broke above the trochanter when attempts were made to pound it against resistance. In both of these patients, adequate bone contact at the osteotomy site had been gained at the primary operation. In Case 5 (S. Van H.), however, the osteotomy

FIG. 9-A FIG. 9-B FIG. 9-C

Figs. 9-A and 9-B: Roentgenograms made on the same day (Fig. 9-A, supine; Fig. 9-B, standing) three weeks after femoral shortening show the "trombone" action of the femur on the nail.

Fig. 9-C: Roentgenogram shows the result two months after the application of staples to the osteotomy site.

site could not be approximated. A week later at re-operation, contact at the osteotomy site was obtained.

In two patients, the Küntscher nail was found to be loose at the time of the primary operation. In one (Case 2, T. Mc.), staples were added at the osteotomy site primarily. Union occurred without complication; in the other (Case 10, C. M.), a "trombone" motion of the femur on the nail developed which required secondary stapling at the osteotomy site three weeks later. Satisfactory healing occurred.

Postoperative Complications

There were only four postoperative complications in the forty femoral shortenings done by means of oblique osteotomy.

There were fourteen postoperative complications in the eleven femoral shortenings done by means of transverse osteotomy with Küntscher-nail fixation. Painful irritation caused by the proximal tip of the nail occurred in six patients. In one patient (Case 6, E. S.), there developed severe and disabling gluteal pain, accompanied by sciatic radiation, which was relieved by the removal of the Küntscher nail.

In two patients, mechanical weakness of the nail itself appeared to be the complicating factor. In one (Case 7, W. L.), the Küntscher nail employed at the first operation was insufficiently tempered and angular deformity developed after one month. Despite the replacing of the nail and additional bone-grafting upon two occasions and the use of one

TABLE III

	Oblique Osteotomy and Screw Fixation	Transverse Osteotomy and Küntscher-Nail Fixation
Average follow-up	2.5 years	1 year
Time of ambulation with crutches		
Earliest	2 weeks	First postoperative day
Latest	12 weeks	10 weeks
Average	8 to 10 weeks	Within first postoperative month
Time of ambulation without crutches		
Earliest	12 weeks	Second postoperative week
Latest	8 months	Fourth postoperative month
Average	3 to 4 months	6 to 8 weeks
Delayed union	1 in 40 patients	4 in 11 patients
Non-union	0	1

half of a nail as a filler in the proximal fragment, fixation was not secure. Union did not occur; eventually inlay and onlay grafts were required, together with prolonged spica immobilization to secure healing. This is the one instance of frank non-union. In the other patient (Case 9, S. V.), fracture of the nail occurred five and one-half months after the procedure.

Genu Recurvatum

In four patients treated by means of the transverse osteotomy with Küntscher-nail fixation, genu recurvatum deformity developed postoperatively (Case 2, T. Mc.; Case 6, E. S.; Case 8, M. A.; and Case 9, S. V.). In all except one of these (Case 9, S. V.), the femur had been shortened five centimeters or more. Genu recurvatum persisted in three of these patients from one to five months, and in one (Case 9, S. V.), there was still genu recurvatum two years later. We believe that this complication was due to temporary partial loss of muscle tone in the thigh. That this was not seen in those patients whose femora had been shortened by means of the oblique osteotomy is probably due to the thigh muscles regaining tone during the period of postoperative bed rest. In both groups of patients, however, there was a variable period of weakness in active extension at the knee. In one patient treated by transverse osteotomy with Küntscher-nail fixation (Case 10, C. M.), there was marked weakness in the last 30 degrees of active extension without true genu recurvatum.

Convalescence

Earlier postoperative ambulation was permitted in the patients who had femoral shortening done by means of transverse osteotomy with Küntscher nailing (Table III). These patients were usually walking with crutches within one or two weeks, as contrasted to the six to ten weeks for those with oblique osteotomy. Crutches were discarded by the patients treated by transverse osteotomy with Küntscher nailing at approximately the same time that crutch walking was begun in those treated by oblique osteotomy.

Secure healing as shown by x-ray was obtained more rapidly in the patients treated by oblique osteotomies, usually by the fourth month. While abundant peripheral callus was early in appearance in patients treated by the transverse osteotomy and Küntscher nailing, obliteration of the osteotomy site frequently took from eight to ten months. This type of bone healing suggests that fixation by the intramedullary nail in the shortened femur is not entirely secure.

In the patients treated by oblique osteotomy, delayed union was observed in only one patient beyond five months. In those treated by transverse osteotomy and Küntscher

nailing, there was the only case of non-union; four out of eleven patients in this group had delayed union beyond a period of five months postoperatively.

SUMMARY

1. Between 1938 and 1951, forty patients at the Hospital for Special Surgery have had femoral shortening done by oblique osteotomy with screw fixation.

2. From 1948 through 1951 inclusive, there have been eleven patients with femoral shortening done by transverse osteotomy with intramedullary Küntscher-nail fixation.

3. In both groups, from 2.5 to 8.1 centimeters of femoral shortening have been accomplished.

4. In the former group, only three secondary operations were needed among forty patients; in the latter group, twelve secondary operative procedures were required for eleven patients.

5. Only one operative complication and four postoperative complications occurred in the much larger group treated by oblique osteotomy and screw fixation, while seven operative and thirteen postoperative complications occurred in the smaller group treated by transverse osteotomy and intramedullary nailing.

6. Postoperative external support by balanced suspension or spica for eight to ten weeks after femoral shortening by oblique osteotomy was followed by more rapid and consistent bone healing than was observed after transverse osteotomy, Küntscher intramedullary-nail fixation, and early ambulation.

CONCLUSIONS

1. Secure internal fixation is not provided by the intramedullary Küntscher nail alone after femoral shortening.

2. The use of staples to prevent distraction of the bone fragments has been successful.

3. Early ambulation before the restoration of muscle tone should be avoided.

4. The transverse osteotomy with intramedullary fixation for femoral shortening is not a simple procedure and may be attended by serious complications.

5. Since the oblique osteotomy with screw fixation has been so uniformly successful, it is our opinion that this method of femoral shortening is preferable to the transverse osteotomy with intramedullary nail fixation.

REFERENCES

Böhler, Jörg: Results in Medullary Nailing of Ninety-five Fresh Fractures of the Femur. J. Bone and Joint Surg., **33-A:** 670–678, July 1951.

Calvé, Jacques, and Galland, Marcel: A New Procedure for Compensatory Shortening of the Unaffected Femur in Cases of Considerable Asymmetry of the Lower Limbs (Fractures of the Femur, Coxalgia, etc.). Am. J. Orthop. Surg., **16:** 211–235, April 1918.

Camera, Ugo: 32 casi di accorciamento dell'arto inferiore sano a scopo ortopedico: indicazioni, tecnica, resultati. Chir. d. Org. di Movimento, **17:** 569–587, 1933.

Deutschländer, Carl: Die Heinische Operation der Kontinuitätsverkürzung zwecks Ausgleichung von Längendifferenzen der unteren Gliedmassen. Zeitschr. f. Orthop. Chir., **19:** 47–54, 1908.

Fassett, F. J.: An Inquiry into the Practicability of Equalizing Unequal Legs by Operation. Am. J. Orthop. Surg., **16:** 277–287, Sept. 1918.

Glaessner, Paul: Die Kontinuitätsresektion der langen Röhrenknochen zur Ausgleichung von Verkürzungen. Zeitschr. f. Orthop. Chir., **19:** 39–46, 1908.

Groves, E. W. Hey: An Address on Stature and Poise: The Problem of Unequal Legs. British Med. J., **2:** 1–5, 1931.

Howorth, M. B.: Leg-Shortening Operation for Equalizing Leg Length. Arch. Surg., **44:** 543–555, 1942.

Ingelrans, P.; Vendeuvre, A.; et Mlle. Nicoul: Trois observations d'accourissement pour inégalité des membres inferieurs. Rev. d'Orthop., **34:** 177–179, 1948.

Leveuf, Jacques: Results of Open Reduction of "True" Congenital Luxation of the Hip. J. Bone and Joint Surg., **30-A:** 875–882, Oct. 1948.

McCarroll, H. R.: Trials and Tribulations in Attempted Femoral Shortening. J. Bone and Joint Surg., **32-A:** 132–142, Jan. 1950.

Moore, J. R.: Tibial Lengthening and Femoral Shortening. Pennsylvania Med. J., **36**: 751–755, 1933.

Moore, R. D.: Supracondylar Shortening of the Femur for Leg Length Inequality. Surg., Gynec., and Obstet., **84**: 1087–1094, 1947.

Phalen, G. S., and Chatterton, C. C.: Equalizing the Lower Extremities. Clinical Consideration of Leg Lengthening versus Leg Shortening. Surgery, **12**: 768–781, 1942.

Royle, N. D.: The Treatment of Inequality of Length in the Lower Limbs. Med. J. Australia, **1**: 716–718, 1923.

Sorondo, J. Pineiro: Acortamiento quirúrgico de un miembro inferior. Su technica. Rev. Assn. Med. Argentina, **62**: 73–77, 1948.

Straub, L. R.; Thompson, T. C.; and Wilson, P. D.: The Results of Epiphysiodesis and Femoral Shortening in Relation to Equalization of Limb Length. J. Bone and Joint Surg., **27**: 254–266, Apr. 1945.

Street, D. M.: One Hundred Fractures of the Femur Treated by Means of the Diamond-Shaped Medullary Nail. J. Bone and Joint Surg., **33-A**: 659–669, July 1951.

Stuck, W. G., and Thompson, M. S.: Complications of Intramedullary Fixation of Fractures of the Femur. Arch. Surg., **63**: 675–686, 1951.

White, J. W.: Femoral Shortening for Equalization of Leg Length. J. Bone and Joint Surg., **17**: 597–604, July 1935.

White, J. W.: Overlapping Procedure for Shortening Bone Defects. *In* Lectures on Reconstruction Surgery of the Extremities. Instructional Course Lectures. The American Academy of Orthopaedic Surgeons, 1944. Ann Arbor, J. W. Edwards, 1944.

Wilson, P. D., and Thompson, T. C.: A Clinical Consideration of the Methods of Equalizing Leg Lengths. Ann. Surg., **110**: 992–1015, 1939.

DISCUSSION

Syme Amputation Performed in Two Stages

(*Continued from page 42*)

patients without infection, ulceration, or sloughing. The heel pad is shrunk by the preliminary weight-bearing in the plaster boot, and the circulation in the area of the incision, which is not always perfect, is greatly improved by the time of the final revision.

I think that this operation can save many of those with badly infected feet from a below-the-knee amputation and can allow them an effective Syme stump. This will make available to them the greatly improved prosthesis which Colonel Spittler and his group have perfected.

Lieutenant Colonel Brennan (closing): The patient with Buerger's disease and with gangrene of the foot was forty years of age. The procedure was performed to eliminate infection. Healing after the first stage of the procedure proved the skin of the heel pad to be viable. The second stage was then completed and resulted in a satisfactory end-bearing Syme stump. He was successfully fitted with a prosthesis. We do not recommend this amputation ordinarily for Buerger's disease.

I agree with Dr. Atha Thomas that a Syme amputation is not ordinarily satisfactory for women, but there are exceptions. If this amputation is to be used for women, they must be stable individuals. The objection is the unsightly appearance of the ankle part of the prosthesis.

The first stage of the procedure—that is, the disarticulation of the ankle—is recommended in preference to below-the-knee guillotine amputations, since it can be done even by the occasional operator. The technique is not too difficult. It does require knowledge of the anatomy of the foot and ankle as well as prior surgical training of the surgeon. However, the positioning and redundancy of the amputation pad are not too important in the first stage. If the surgeon lacks training in amputations, he has adequate time to refer the patient to an orthopaedic surgeon for the finished second stage, at which time imperfections can be corrected.

The two-stage Syme procedure has been so successful that some surgeons have asked why we do not perform all Syme amputations in two stages. It is an interesting thought. We continue to perform the classical Syme amputations in one stage where all of the previously reported preoperative requirements have been met. Because of the psychological trauma and the necessity of a second surgical procedure, I do not believe we are warranted in performing the procedure in two stages in ideal cases.

The success in this series of cases does not in any way lessen the requirements for strict aseptic technique. Previously recognized surgical principles must not be abandoned. This procedure is advocated only for those patients with infection who would not previously have been considered suitable for Syme amputations. Previously, all such patients would have had below-the-knee amputations or prolonged healing periods and other multiple surgical procedures. The success in these patients shows that many patients of this type can be offered the advantages of a Syme amputation by the two-stage method originally introduced into Walter Reed Army Hospital by Dr. Alvin Hulnick.

MANGLE AND SEVERE WRINGER INJURIES OF THE HAND IN CHILDREN*

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Wringer injuries have been recognized in children ever since the advent of the power-driven washing machine. In 1938, MacCollum[6] coined the name "wringer injury". Originally he had reported twenty-six cases, and recently he added 116 cases[7]. Allen, in a two-year period, was able to collect 107 cases. Hausmann and Everett reported a series of ninety-seven patients, and emphasized the importance of early treatment. That these injuries can be serious, not only to limb but also to life, is emphasized by the fact that there were two deaths in a series of sixty-four cases reported by Schulz.

Since 1935, we have admitted twenty-three patients with severe wringer injuries to the Children's Hospital of Michigan in Detroit. One of these had a definite radial-nerve paralysis. In another, the thumb, ring and little fingers were amputated. Twelve of these injuries required skin-grafting to the elbow region, and in three cases both the elbow and the axilla were involved. Only five patients required skin-grafting to the hand. In three cases the extremity was swollen and painful but responded to aspiration and conservative methods. One child had had an open ulcer on his elbow for three years before he came to the Hospital and had the defect closed with a pedicle graft. There were no deaths.

The mechanism of the injury is rather simple. The child, usually rather young, is attracted by the rolling portion of the wringer and puts his fingers between the rollers. In the classical case, the rollers either stop at the supracondylar area or at the axilla. Destruction of the underlying tissues continues until the machine is stopped. We have encountered several severe cases in which the thumb prevented the hand from going through the rollers and severe injury was caused to the palm of the hand. Unfortunately, when a child is caught, rather than the safety release being sprung, many times the hand is forcibly pulled out or the mechanism is reversed. This causes, as Allen points out, a crushing of the extremity on the way in and a tearing on the way out. Severe compression of the tissues occurs, causing first ischaemia, then swelling, and later extravasation of blood into the tissues beneath the skin or superficial fascia.

With the advent of the automatic washing machine and the perfection of the release mechanism, not to mention automatic electric dryers, the incidence of wringer injuries has decreased. However, the number of mangle injuries of the hand in children has markedly increased as more and more homes have become equipped with ironers. These mangles consist of a rolling mechanism and a cast-iron shoe. In this type of injury, we not only have the mechanical effect of the roller, but in addition the effect of heat, which often produces a severe burn, usually third degree. In fact, in very severe cases, amputation of digits may result (Fig. 4-A).

The severity of these mangle and wringer injuries is not obvious at first. Although bruising is visible, the severe oedema and effects of the burn become apparent later.

Patients with severe wringer injuries and *all* with mangle injuries should be admitted to the hospital where they can be observed. X-rays should be taken routinely, although the incidence of fractures is low. There was only one fracture among our twenty-three cases. If a laceration has occurred, the wound should be debrided and closed under adequate anaesthesia, usually general. If skin has been avulsed, all of the subcutaneous fat

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should be removed and the skin should be replaced as a full-thickness graft[8] (Figs. 1-A and 1-B). In fact, even the attached end of the pedicle can be sectioned and replaced as a graft. Open areas, if clean, should be promptly covered by split-thickness grafts. Usually, only bruising of the skin and swelling occur, for which most authors advocate a petrolatum-gauze pressure dressing and a splint. The extremity should be elevated and cold packs may be applied. The wound should be inspected three times at intervals of twelve hours [7]. If severe oedema and swelling or a hematoma develop, then incision and drainage must be performed. The incidence of necrosis of the skin is much lower if the patients are carefully followed and handled in this manner.

The proper dressing for severe wringer or mangle injuries should consist of a petrolatum-gauze dressing, small gauze squares on the involved area and between the fingers, gauze fluffs, gauze roll bandage, a splint (preferably metal), and an elastic bandage extending from the finger tips to the axilla. An analgesic may be given. If the skin has been broken and there is danger of infection, procaine penicillin may be used.

FIG. 1-A

Fig. 1-A: Case 1 illustrates severe wringer injury with avulsion laceration of the skin of the left palm and necrosis of the skin of the forearm in an eight-year-old boy. Primary suture of the defect was carried out immediately under general anaesthesia after the subcutaneous fat had been removed from the skin flap.

Fig. 1-B: One week after the injury, good healing of the palm was apparent, but necrosis of the forearm had continued. The skin of the forearm was debrided and a gauze pressure bandage was applied.

Fig. 1-C: Granulating surface at the end of three weeks when a split-thickness skin graft was applied.

Fig. 1-D: At the end of four weeks the defect was well covered with the graft, which, although it was thin, was healing well. Good return of function was noted.

FIG. 1-B

FIG. 1-C

FIG. 1-D

The child with wringer injuries can be sent home if it appears after inspection of the wounds and observation of the child for twenty-four hours that no loss of tissue will result. With mangle injuries, however, there usually is loss of skin, if not of tendons and bones, so that it is imperative that any child with this injury be hospitalized. At the end of a week, débridement of the necrotic tissue may be carried out and a split-thickness skin

FIG. 2-A

FIG. 2-B

Fig. 2-A: In Case 2, a wringer injury of the palm one week before this picture was taken had destroyed all flexor tendons and nerves, as well as the blood supply to the index and middle fingers, in the left hand of a six-year-old boy. The thumb prevented the entire hand from going through the wringer, so that the rollers kept rolling on the palm.

Fig. 2-B: The injury was treated with gauze pressure dressings frequently changed.

FIG. 2-C

FIG. 2-D

Fig. 2-C: At the end of three weeks, healthy granulation tissue was present. The index and middle fingers were gangrenous and were amputated, all viable skin on the dorsal aspect being preserved.

Fig. 2-D: Dorsal flaps of skin from the index and middle fingers were used to cover the defects after excision of the exposed metacarpal heads, and a split-thickness skin graft from the right thigh was used to cover the rest of the palm. A stent was used to maintain pressure on the graft.

FIG. 2-E

FIG. 2-E

A tube pedicle graft was started on the abdomen and, four weeks later, it was sutured to the hand. The split-thickness skin graft and all scar tissue were removed from the palm. The flexor tendons and neurovascular bundle that had retracted toward the wrist were freed and sutured as far into the distal palm as possible, opposite the metacarpal head. The tube pedicle was opened and placed on the palm of the hand. A body cast was applied, including the trunk, left arm, and left shoulder. Three weeks later, the pedicle was detached from the abdomen. Tendon grafts and the removal of fat from the pedicle graft are planned.

graft may be applied, or the area may be allowed to slough and is then debrided. Skin-grafting is usually done between the fourteenth and twentieth day (Figs. 1-C and 1-D). On the palm, these grafts usually are considered only temporary, in order to cover the wound and control infection; for, as Allen and others have stated repeatedly, contractures will occur (Fig. 3-A) with split-thickness grafts. Occasionally, on the dorsal aspect of the hand, a thick split-thickness skin graft will be adequate. As Woughter has pointed out, thin (fifteen-millimeter) split-thickness grafts will contract 50 to 70 per cent.; three-quarter thickness (fifty to sixty millimeters) grafts will contract 20 to 40 per cent.; and full-thickness skin grafts will contract 15 to 20 per cent.

Usually at the end of two or three months the child is readmitted to the hospital; the contracting skin graft and underlying scar tissue are carefully excised; and a full-thickness skin graft, taken from the upper thigh or the lower abdomen, is applied (Figs. 3-B, 3-C, and 3-D). We have no hesitancy in using free full-thickness grafts to cover these defects. If cut to pattern and sutured in place carefully, the results are excellent. As Dupertuis has emphasized, however, full-thickness grafts from the back, chest, and upper abdominal regions do not take well because of the thickness of the skin in these regions.

FIG. 3-A

The operative procedure is carried out under general anaesthesia in a bloodless field, obtained by the use of a blood-pressure cuff inflated to 240 millimeters of mercury. After the scar has been excised, a pattern of the exposed area is made with paraffinized mesh gauze or crinoline. The graft corresponding to the pattern is then cut from the upper portion of the thigh with a sharp knife, care being taken to remove only the skin with no subcutaneous fat. The graft is carefully sutured in place with interrupted and continuous 00000 dermalon sutures. Several small openings are made for drainage, and a petrolatum-gauze and a moist cotton dressing are applied[5, 10]. Gauze squares, a splint, and an elastic bandage are placed over these. This dressing is left on for a week, and then, in the operating room under general anaesthesia, the sutures are removed and the hand is redressed

FIG. 3-B

FIG. 3-C

Fig. 3-A: A split-thickness skin graft had been applied as a temporary covering to a wringer injury of the palm with destruction of skin; contractures had developed at the end of three months.

Fig. 3-B: Skin and scar tissue were excised.

Fig. 3-C: A full-thickness skin graft taken from the lower portion of the abdomen was sutured into place and a pressure dressing was applied.

FIG. 3-D

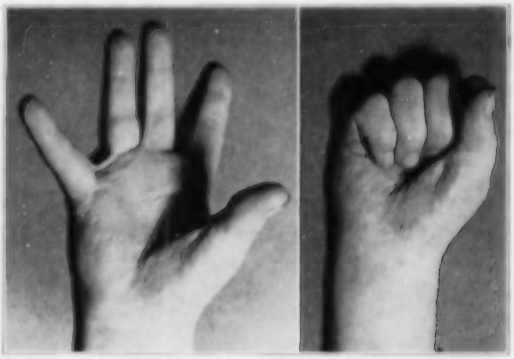

FIG. 3-E FIG. 3-F

Fig. 3-D: Six weeks later, the skin graft had taken well.

Figs. 3-E and 3-F: One and one-half years later, after further correction of contracture in web between thumb and index finger, the patient has full function of the hand.

on the same splint. After another week the graft can be left exposed, but the splint is continued day and night, for a total of three weeks, to prevent contractures. It is then omitted during the day, but is still used at night for three to four months. If there is a tendency for the skin graft to contract, the splint is left on until noon every day until the skin is normal.

If the injury is so severe that tendons and nerves have been destroyed, a pedicle graft may be necessary to provide adequate covering (Figs. 2-A to 2-E). In fact, a pedicle tube may be raised when the split-thickness skin graft is applied at the primary procedure.

CONCLUSIONS

The importance and seriousness of wringer and mangle injuries have been emphasized. In most wringer injuries the trauma to the hand is comparatively slight, the most serious

FIG. 4-A

FIG. 4-B

Fig. 4-A: All of the fingers on the left hand of a three-year-old boy were lost as a result of a severe mangle injury (palmar view).

Fig. 4-B: In order to preserve as much of the digits as possible, demarcation was allowed to occur (dorsal view). Daily soaks were given. Debridement and grafting were performed thirty days after injury.

FIG. 4-C

FIG. 4-D

Figs. 4-C and 4-D: A month later, small grafts were applied to the tips of the stumps. The webbing between the fingers was partially corrected later on. The child now has good function, although the tip of the stump of the index finger tends to break down.

injury occurring about the elbow and axilla. With mangle injuries of the hand, the mechanism of injury is the same, but in addition to the effect of rolling, there is a thermal burn.

The treatment of both injuries is basically the same. Attempts are made to clean the wound as early as possible and this is done at the end of five to seven days, by mechanical debridement. Split-thickness skin grafts should be applied early to prevent secondary infection and to minimize scar formation. The wound should be closed by the fourteenth to the twenty-first day.

Later, in the case of palmar defects, the contracted skin graft is excised and full-thickness skin grafts are applied. A tube pedicle graft may be necessary if tendons and nerves have been destroyed. Postoperative splinting and physical therapy are necessary to prevent recurrence of contractures and to restore function.

REFERENCES

1. Allen, H. S.: Wringer Injuries of the Upper Extremity. Ann. Surg., **113:** 1101–1102, 1941.
2. Brown, J. B., and McDonnell, Frank: Skin Grafting of Burns: Primary Care, Treatment, and Repair. Ed. 2, pp. 128–150. Philadelphia, J. B. Lippincott Co., 1949.
3. Dupertuis, S. M.: An Evaluation of Skin Grafts for Hand Coverage. J. Bone and Joint Surg., **34-A:** 811–819, Oct. 1952.
4. Hausmann, P. F., and Everett, H. H.: Wringer Injury. Surgery, **28:** 71–74, 1950.
5. Lange, W. A.: Personal communication.
6. MacCollum, D. W.: Wringer Arm. A Report of 26 Cases. New England J. Med., **218:** 549–554, 1938.
7. MacCollum, D. W.; Bernhard, W. F.; and Banner, R. L.: The Treatment of Wringer-Arm Injuries. New England J. Med., **247:** 750–754, 1952.
8. Mullholland, J. H., and Mahoney, J. H.: Massive Avulsion of Skin. Am. J. Surg., **83:** 359–363, 1951.
9. Schulz, Irwin: Wringer Injury. Surgery, **20:** 301–302, 1946.
10. Tanzer, R. C.: Prevention of Postoperative Hematoma in Surgery of the Hand: The Use of the "Compression Suture". J. Bone and Joint Surg., **34-A:** 797–804, Oct. 1952.
11. Woughter, Harold: Personal communication.

DISCUSSION

Dr. George S. Phalen, Cleveland, Ohio: All too frequently, the physician who first sees a mangle or wringer injury of a hand does not recognize the seriousness of the injury and fails to institute the proper initial treatment to prevent excessive swelling and necrosis of the skin. If a copious pressure dressing is not applied promptly, and if the arm is not kept constantly elevated to prevent undue swelling, the severe oedema of the hand which is certain to develop over the next twelve to twenty-four hours may not disappear for many weeks, and may easily leave some residual stiffness and deformity of the small joints of the hand, as well as some fibrosis along the tendon sheaths.

Unfortunately, adults as well as children receive mangle and wringer injuries of their hands. Hospitalization of these patients is much to be preferred to out-patient treatment.

In the treatment of adults, we have occasionally employed cervical sympathetic blocks to aid in the control of severe oedema. I would like to ask Dr. Posch if he has used stellate blocks in the treatment of any of his patients.

Children do not cooperate with the surgeon in the protection of their hands after various surgical procedures. A full-thickness skin graft may easily be lost if adequate immobilization of the hand is not obtained for at least several days following application of the graft. The use of stents and pressure dressings may not be sufficient to prevent little fingers from wiggling inside the dressing just enough to cause a hematoma beneath the graft. I have found it helpful in these cases to tie each tiny finger securely to a metal splint by passing a loop of thin stainless-steel wire through the finger nail. These wires may be removed at the time of the first dressing.

I wish to commend Dr. Posch on the excellent results he has obtained in these difficult cases.

Dr. S. M. Dupertuis, Pittsburgh, Pennsylvania: Dr. Posch has outlined in detail the proper management of these injuries in children. Several features relating to graft coverage, however, deserve re-emphasis, and we wish to call attention to a somewhat newer concept in the treatment of localized mangle burns of the hand.

Frequently free split grafts of approximately one-half thickness of the skin may be applied to granulation surfaces at the proper time; usually they take well and provide adequate surface coverage which does not require later replacement. Split-thickness skin grafts to replace dorsal scar contractures are excellent, since the hand, in the normal flexed position of rest or function, stretches these grafts, and shrinkage or tightness is seldom seen. The replacement of contracted burn scar on the palm, however, usually requires a free full-thickness graft, because of a natural tendency to contract and wrinkle, but on occasions a split graft of approximately three-quarters thickness provides an equally good result.

In the early treatment of burns on the dorsum of the hand we agree with Braithwaite [a], who advocates surgical excision of the slough by the twelfth day with immediate application of a split skin graft to prevent fibrosis of the delicate dorsal extensor mechanism. In 1950, W. P. Dallas Ross [b] of England presented a splendid report on the treatment of 323 burned hands, in which he did immediate excision of the localized burned area with application of free skin grafts in fifty cases. Five deeper burns required immediate ab-

(*Continued on page 74*)

MICROWAVE DIATHERMY AND THE HEALING OF EXPERIMENTALLY PRODUCED FRACTURES IN RABBITS *

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In the past, numerous investigations have demonstrated the effect of various hormones, vitamins, minerals, and specialized diets on the healing time and the quality of healing of fractures. Although lack of these factors, such as vitamins and minerals, may delay healing of bone, it has never been conclusively shown that any of these substances can increase the normal rate of healing of fractures. It seems, therefore, that chemical environment has only a negative effect at the fracture site. Less is known of the effect of the physical environment on the healing of fractures. It is well known that bones which are osteoporotic because of osteomalacia heal more rapidly after fracture than do normal bones[1,2]. It is likewise known that increasing the local blood supply to a bone will tend to make that bone osteoporotic. Since the application of heat to an area ordinarily increases the blood flow, it is theoretically possible that application of heat in the correct dosage might accelerate the healing of fractures. In 1939, Kellogg Speed and Fell showed the effect of continuously elevated temperature in the fractured extremity. They used the ingenious device of burying the fractured forelegs of guinea pigs in the abdominal cavity. Both bones were fractured and the healing qualities were compared with those of homologous fractured limbs remaining outside the body. It was their impression, upon examination shortly after fracture, that the bones in the first group had healed better than the control bones. Sweeney and Laurens in 1935 had shown the effect of carbon-arc radiation on the healing time of the fibulae of rats and dogs from which a segment of bone had been removed. They reported that the wave length of radiations seemed to have some effect on the results. The Sunshine-carbon radiation accelerated the healing, while the therapeutic C-carbon radiation retarded it. With the Sunshine-carbon radiation, the healing time of the treated leg averaged 3.7 days less than that of the untreated leg. The fractures were studied by roentgenograms until complete healing occurred, the periods ranging from thirty to seventy-five days. In contrast, Wise, Castleman, and Watkins have reported the results of the use of a single heavy dose of microwave radiation on the growth of the long bones of albino rats. They used such large doses of radiation that in several instances not only the epiphyseal lines but also the surrounding bone and soft tissues were destroyed. In their experiment, the growth of bone was retarded approximately in proportion to the dosage used. In 1951, Hutchison and Burdeaux reported on the effects of short-wave diathermy on bone grafts and on the repair of fractures in rabbits. They used small doses of radiation twice daily for thirty days and found some delay in the healing time both in the bone grafts and in the fractures.

In the experiment on which this report is based, it was hoped to approximate clinical conditions as nearly as possible. It was proposed to determine whether heat applied locally to the fracture site, without other treatment, influences the rate or quality of healing of fractures. It also was hoped to apply microwave diathermy in doses comparable to those which would be used in clinical medicine.

* Read at the Surgical Forum of the American College of Surgeons, New York, N. Y., September 24, 1952.

FIG. 1
Director C.

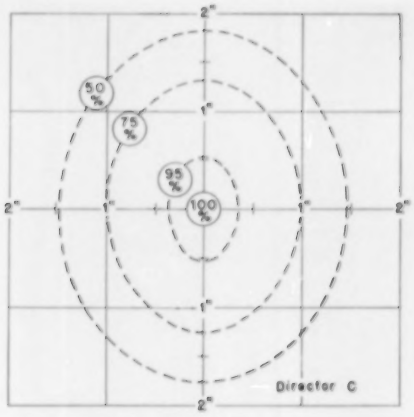

FIG. 2
Surface heat pattern of director *C*.

MATERIAL AND METHODS

For this experiment, rabbits were used because they are large enough to work with easily. Fractures were produced in the ulna alone in the hope that the radius would splint the fracture, so that healing of the fracture in good position would be allowed and the animals would be kept in good health. Both of these conditions were obtained. To produce the fracture, the rabbits were anaesthetized by the intravenous administration of pentobarbital sodium. They were placed on the operating table in the prone position with the forelegs outstretched. The ulnae were exposed by a longitudinal incision which followed intramuscular septa overlying the bone. The periosteum was stripped enough to allow a periosteal elevator to be inserted around the ulna. A transverse fracture was then made with a single sharp transverse cut with a small osteotome. Comminution of the fracture thus produced was inversely proportional to the sharpness of the osteotome and the skill of the operator.

Preliminary Experiment

A preliminary experiment was carried out to determine the dosage of microwave energy which would raise the temperature in the medullary cavity of the ulna in intact rabbits to about 40 degrees centigrade from the resting level of 34.4 to 35.6 degrees centigrade. To accomplish this, a small incision was made over the subcutaneous aspect of the ulna, and a hole was drilled into the cortex of the ulna with a dental burr after a local anaesthetic had been administered. The temperature was measured by means of thermistors which were inserted in the drilled holes. The skin was then sutured about the wires coming from the thermistor. Thermistors were used because they can be left *in situ* during microwave radiation without the secondary heating effects (caused by electric currents) which may be present when thermocouples are used. The energy was generated by a microwave generator operating at a wave length of approximately twelve centimeters. Microwave energy was transmitted from director *C* (corner-reflector type) which delivers an oval-shaped surface heat pattern (Fig. 1). This region of maximal energy was approximately one centimeter in diameter when the director was at a distance of two inches (about five centimeters) from the surface to be heated (Fig. 2).

In these preliminary experiments, temperatures in the adjacent muscle tissue and the rectal temperature were taken simultaneously. Later, the thermistors were inserted in a similar manner into the hematoma of the fracture and into the callus of the healing fracture. All the rabbits used were adult rabbits with weights varying from 2.5 to 3.5 kilo-

FIG. 3-A FIG. 3-B

Fig. 3-A: Roentgenogram, made fourteen days after production of fracture, of a foreleg treated with microwave diathermy. Comminution of the fracture had been extensive and there was marked displacement of the fragments. The edges of the bones were rounded and indistinct.

Fig. 3-B: Photomicrograph (× 3.25, hematoxylin and eosin stain) of section from the same foreleg. Note the excessive formation of cartilage which extends into the marrow cavity and muscle, as well as the excessive amount of osteoid tissue at the periphery of irregular nodules of cartilage, and focal formation of atypical cartilage.

FIG. 4-A FIG. 4-B

Fig. 4-A: Roentgenogram, made fourteen days after production of fracture, of the opposite, untreated foreleg. The fracture had been badly comminuted, but the bone ends were becoming indistinct.

Fig. 4-B: Photomicrograph (× 3.25, hematoxylin and eosin stain) of the same foreleg showing excessive formation of cartilage and marked elevation of the periosteum.

grams. In the preliminary study, ten experiments were done on five rabbits. In the intact ulna, with the thermistor in place in the medullary cavity, a plate current of twenty-five milliamperes delivered through the microwave generator with the director *C* at a distance of two inches (about five centimeters) from the skin raised the temperature in the medullary cavity to about 40 degrees centigrade without any rise in the rectal temperature. A similar rise in the temperature of the adjacent muscle was noted. In general, the rise of bone temperature varied inversely with the weight of the rabbit. These facts indicated that adequate heating of the fracture site (a rise of 4.4 to 5.6 degrees centigrade) could be obtained without increasing the general body temperature. It seemed, therefore, that the use of the opposite foreleg as a control would be valid. There was some individual difference in the response of the rabbits to heat and at the end of thirty minutes of heating the rectal temperature began to rise in some animals. It was decided, therefore, to use a duration of thirty minutes for each application of heat.

Procedure

Following this preliminary experiment, fractures were produced in the middle of the shafts of both ulnae in seventeen rabbits. Roentgenograms of the fractured limbs of each rabbit were made and a mark was made in the skin over the site of fracture. The exact position of the fracture was determined by comparing the length of the ulna both on the roentgenograms and by actual physical measurement. The fracture site of the left ulna in each of the seventeen rabbits was then exposed to microwaves for thirty minutes eleven times a week. The director *C* was adjusted so that it was two inches (about five centimeters) from the site of fracture, and a current of twenty-five milliamperes was used in the microwave generator. Three of the seventeen rabbits were excluded from the experiment; two of them died as a result of the anaesthetic and the remaining rabbit had a wound

FIG. 5-A

FIG. 5-B

FIG. 6-A

FIG. 6-B

Fig. 5-A: Roentgenogram of treated foreleg, showing good formation of callus seventeen days after fracture.

Fig. 5-B: Photomicrograph (× 3.25, hematoxylin and eosin stain) of a specimen taken from the same foreleg. Note the excessive formation of callus, marked elevation of the periosteum, distortion and fragmentation of much of the cartilage, and abundant amount of connective tissue between the spicules of bone.

Fig. 6-A: Roentgenogram of untreated foreleg made seventeen days after fracture. There was evidence of good formation of callus and absorption of bone at the site of the fracture.

Fig. 6-B: Photomicrograph (× 3.25, hematoxylin and eosin stain) of the same foreleg. There was evidence of healing of the fracture, excessive formation of cartilage, and elevation of the periosteum.

infection on one side. One rabbit was killed at the end of one week after production of the fractures, eight were killed at two weeks, and five at three weeks. Roentgenograms of both forelegs were obtained the day before the animals were killed. The fractured portion of each radius and ulna was dissected *en bloc* and was decalcified. The segments of the ulna were then cut longitudinally and were stained and mounted on glass (Figs. 3-A through 4-B). Another procedure then was used, that is, the thermistor was inserted into the medullary cavity adjacent to the fracture site. It was found that, in the presence of hematoma or callus, a higher dosage of microwave diathermy could be used without causing an increase in the rectal temperature. It was noted that thirty-five milliamperes could be used in the microwave-generator machine and that this resulted in local heating at the fracture site with temperatures above 40 degrees centigrade. In one rabbit, this procedure was repeated with consistent results on the first, third, seventh, ninth, and fifteenth days after the production of the fractures.

Additional Experiments

After this information had been obtained, five more rabbits were treated in the same manner as the seventeen previous rabbits. In each case the left foreleg was irradiated eleven times a week. These rabbits were all treated with doses of thirty-five milliamperes and were killed seventeen days after the production of the fractures (Figs. 5-A through 6-B).

RESULTS

At the time the animals were killed and blocks of the bones of the forelegs were removed, there was no gross difference between the two sides in the amount or quality of callus formation or in the clinical degree of union of the fracture. There were individual variations, but these were not consistently present on one side rather than the other.

Similarly, a review of the roentgenograms failed to reveal any evidence that healing was of better quality or took place more rapidly on one side as compared with the other. Since these were all adult animals, no observations were made concerning the effect of microwave diathermy on growth.

The microscopic sections were examined by one of us (Bennett), who did not have any prior knowledge as to which legs had been treated. A review of his notes revealed that on the treated side there was slightly more irregular calcification, less residual cartilage, more connective tissue, and more blood vessels as compared with the untreated or control side. The small amount of difference which was found can best be illustrated by the fact that, when the pathologist was asked to judge in each case which side he felt was the treated side, he was correct only half of the time. It is probable that the amount of periosteal stripping which was done at the time the fractures were produced, as well as the variation in the fractures themselves and in the degree of comminution, was the reason for the variations in the specimens.

There was no correlation between the quality of bone repair and the degree of comminution of the original fracture. In all sections, there was a great deal of subperiosteal-bone formation and connective-tissue formation, probably because of elevation of the periosteum. In all animals which were killed two weeks or more after production of the fractures, there was gross clinical evidence of early bony union. None of these animals were spared long enough for true consolidation of the fracture to take place, as judged either clinically or by roentgenographic examination.

COMMENT

The dosage of microwave diathermy which was applied to the left ulna in nineteen rabbits, and which varied from twenty-five to thirty-five milliamperes of current in the microwave generator, seemed adequate to raise the local temperature at the fracture site to about 40 degrees centigrade without causing a general rise of body temperature in the animal, when this treatment was not continued beyond thirty minutes. This amount of heat does not appear to cause damage to normal tissues and yet is enough to produce local vasodilatation with an increase of blood flow in this area. In the evidence presented in this experiment, there are no conclusive or consistent facts which show that this amount of heat has affected healing of fractures either favorably or adversely in its early stages. The evidence, of course, does not shed any light on what would have happened if the heat treatments which were used twice a day had been continued until full consolidation of the fractures had taken place and it does not show what would have happened if the fractures had been allowed to consolidate after two or three weeks of daily radiation.

REFERENCES

1. Ghormley, R. K., and Stuck, W. G.: Experimental Bone Transplantation. With Special Reference to the Effect of "Decalcification". Arch. Surg., **28**: 742–770, 1934.
2. Goisman, Joseph, and Compere, E. L.: The Healing of Fractures of Atrophic Bones. J. Bone and Joint Surg., **20**: 587–603, July 1938.
3. Hutchison, W. J., and Burdeaux, B. D., Jr.: The Effects of Short-Wave Diathermy on Bone Repair. J. Bone and Joint Surg., **33-A**: 155–165, Jan. 1951.
4. Speed, Kellogg, and Fell, E. H.: Temperature-Controlled Healing of Experimental Fractures. J. Bone and Joint Surg., **21**: 1005–1011, Oct. 1939.
5. Sweeney, H. M., and Laurens, Henry: Effect of Carbon Arc Radiation on Healing of Bone. Arch. Surg., **31**: 395–418, 1935.
6. Wise, C. S.; Castleman, Benjamin; and Watkins, A. L.: Effect of Diathermy (Short Wave and Microwave) on Bone Growth in the Albino Rat. J. Bone and Joint Surg., **31-A**: 487–500, July 1949.

ASPIRATION BIOPSY OF THE SPINE*

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The problem of making diagnoses in obscure lesions of the vertebral column has always been difficult. In 1940, several patients with such lesions were sent to our Clinic within a short period. When it became obvious that the usual clinical and laboratory procedures would be of little aid in making a diagnosis, we developed, in conjunction with members of the Surgical Department, what we felt was an adequate approach to "blind" biopsy of the spine. We used the method on three patients and were gratified that we were able to complete a diagnosis in two of them.

After a review of the literature, we found that Robertson and Ball in 1935 had presented a report of six cases diagnosed by aspiration biopsy of the spine. They gave a brief description of their technique, which included the use of a No. 18 or No. 16 needle, four inches in length, introduced into the tumor area.

In 1948, Valls and his associates reported on a number of cases successfully diagnosed by aspiration biopsy. We found their method to be superior to ours and we adopted the major part of their technique. Valls and his group reviewed the anatomy of the spine and suggested the anatomical contra-indications.

All of the lesions of the spine in our series appeared in the thoracic, lumbar, and sacral portions of the spine. Our technique was developed to approach these areas and we have had no experience with lesions in the cervical spine. An excellent description, however, was given by Valls and his associates of the approach to lesions involving some portions of the cervical spine.

ANATOMY

1. *The thoracic spine:* The bodies of the first to the tenth thoracic vertebrae are in fairly intimate contact with the parietal pleura, while the descending aorta and accompanying veins and the thoracic duct are close to the upper five thoracic vertebrae. Aspiration biopsy above the ninth thoracic vertebra, therefore, carries with it some danger of damage to important structures (Fig. 1).

2. *The lumbar spine:* The aorta lies anteriorly and to the left of the vertebral bodies in the lumbar spine. The inferior vena cava is anterior also and slightly to the right. The vessels lie an average of 9.5 to 10.5 centimeters from the surface of the skin.

The renal pedicles extend from the eleventh thoracic to the third lumbar vertebra and lie an average distance of nine centimeters from the skin (Fig. 2).

TECHNIQUE

All aspiration biopsies are now done under roentgenographic control with the patient anaesthetized, preferably by pentothal sodium. The patient is placed in a prone position. We have only recently used anaesthesia because of the tendency of some patients to become nervous. The possibility of the patient moving at the wrong time is therefore eliminated. The spinous process of the involved vertebra is identified and marked. A spot 6.5 centimeters from the mid-line is selected and likewise marked. The skin is punctured with a thin tenotome, and a long one-millimeter stylet is inserted at an angle of exactly 35 degrees toward the mid-line. The stylet has a mark at the seven-centimeter level so that danger of penetration beyond that area is eliminated and with it the danger of striking

* Read at the Clinical Congress of the American College of Surgeons, New York, N. Y., September 24, 1952.

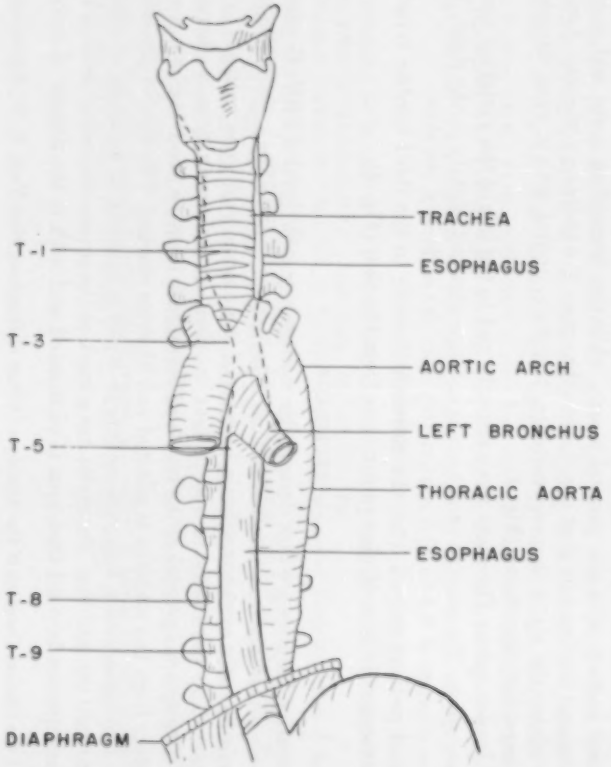

FIG. 1

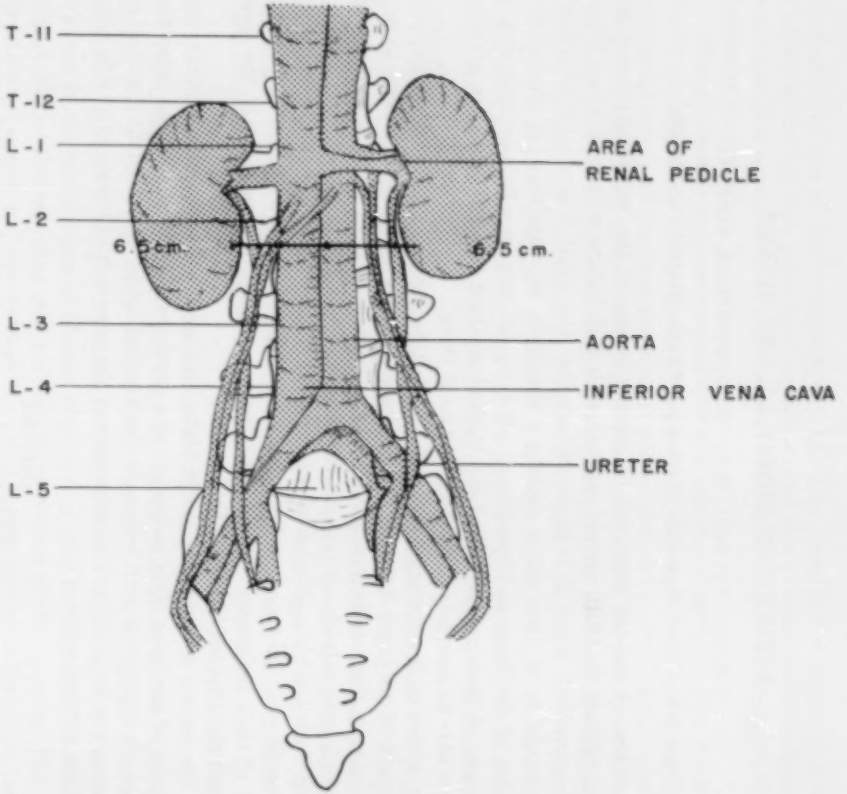

FIG. 2

Fig. 1: The thoracic spine. Showing structures which might be damaged by aspirating needle.

Fig. 2: The lumbar spine. Showing proximate vital organs.

Fig. 3: Case 1, M. L. S. Showing a lumbar lesion. In this case the roentgenographic diagnosis was malignant neoplasm; the diagnosis after aspiration was tuberculosis.

Fig. 3

Fig. 4-A

Fig. 4-B

Fig. 4-A: Case 2, S. S. Showing another lumbar lesion in which the roentgenographic diagnosis was malignant growth and diagnosis after aspiration was tuberculosis.
Fig. 4-B: Showing needle at the site of the lesion.

the renal pedicles is diminished. In lumbothoracic aspirations, it must be remembered that the aorta lies anteriorly, usually about ten centimeters from the skin, and to the left of the vertebrae, while the renal pedicles are usually about eight centimeters from the skin and could be injured by a needle placed at an angle of more than 35 degrees.

When the stylet is felt to strike bone, it is usually turned so as to be embedded slightly. Anteroposterior and lateral roentgenograms are made in the operating room and developed within a period of one minute. If the stylet is found to be favorably placed, a second, larger bore needle with a saw-tooth edge is passed over the stylet and the latter is withdrawn. A fifty-cubic-centimeter syringe is attached to the needle and the needle is turned into the bone tissue while a strong suction pressure is maintained by the syringe. If fluid is aspirated, the syringe is disengaged and the material is saved for smear and culture. The needle may be withdrawn slightly, while contact with the bone is still maintained, and moved to another spot in the vertebra for the aspiration of more bony material. After the needle has been withdrawn, a large core of bony material may usually be released by forcing the stylet through the needle. This material is placed in saline solution and is sent to the pathology laboratory for either frozen or delayed section.

In only one case did we ignore the anatomical contra-indications and aspirate in an area in which we felt that the procedure was hazardous. The patient, a surgeon, understood the contra-indications thoroughly and in despair over failure to make a diagnosis in his own case suggested that an aspiration biopsy be done on the fourth thoracic vertebra. The procedure was carried out by a general surgeon with whom he had worked on this series of cases. Fortunately, the aspiration was done without any complication. It might be added that a diagnosis of low-grade staphylococcic osteomyelitis was made and treatment, which had been withheld, was directed at the lesion with a satisfactory result.

Thirty-four cases in which aspiration biopsy was done are included in this series. The patients' ages ranged from eight months to seventy-two years, the average being 42.6 years.

A definite diagnosis was established in twenty cases. The tissue was lost in two cases, while in twelve cases the material obtained was called either normal or non-pathological by the laboratory.

Healed fracture	1
Tuberculosis	6
Osteomyelitis	2
Tumor	11
Chronic inflammatory tissue	6
Negative (blood or absence of pathological tissue)	8

The tumors included myosarcoma, Ewing's tumor, chordoma, metastatic carcinoma, solitary myeloma, multiple myeloma, and angio-endothelioma.

Eight of the fourteen patients for whom reports were either negative or inconclusive had roentgenographically demonstrable destructive lesions. These patients were treated with x-ray therapy in the absence of a diagnosis. Five of these died within a period of from six to fourteen months, while three could not be followed. The other six patients were treated conservatively and our last follow-up study, made at least four years after aspiration, revealed that four of these patients were still alive, although some of them had complaints of variable back pain.

CASE REPORTS

Case 1. M. L. S., a colored female, forty-four years old, was seen on March 31, 1944, with a history of carcinoma of the cervix which had been treated by radium in 1941. There had been no evidence of recurrence. The patient stated that in January 1944 she had had influenza, associated with a backache and passage of blood in the urine. Physical examination was non-contributory. Findings at routine laboratory examination were all within the limits of normal. Roentgenographic examination of the lumbosacral spine revealed a destructive lesion in the body of the second lumbar vertebra which was believed to be metastatic.

FIG. 5-A

Fig. 5-A: Case 3, A. J. H. Low-power photomicrograph (× 100). In this case the roentgenographic diagnosis was actinomycosis and the diagnosis after aspiration was angio-endothelioma.

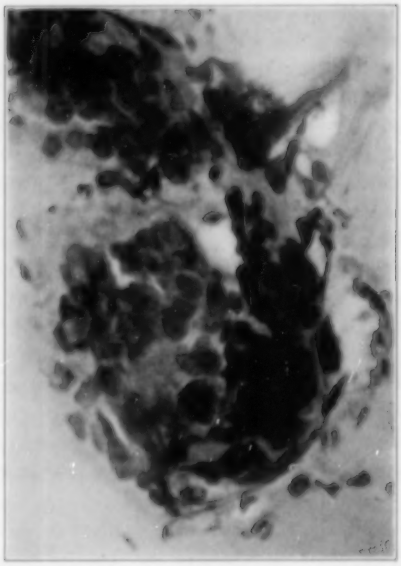

FIG. 5-B

Fig. 5-B: High-power photomicrograph (× 425).

Aspiration biopsy of the second lumbar vertebra was carried out and pus was obtained which was positive for tubercle bacilli on direct smear (Fig. 3).

CASE 2. S. S., a white male, forty-five years old, was admitted to the Hospital on May 4, 1949, with a complaint of low-back pain of four months' duration. The onset had occurred suddenly, while he was shoveling coal. There was no radiation of pain. The patient had been hospitalized elsewhere and placed in a body cast for four weeks with complete relief of pain. The pain recurred, however, almost immediately after removal of the cast and the patient was admitted to this Hospital for diagnosis and treatment. The only other pertinent findings in the history were anorexia and night sweats. Physical examination was not remarkable except for tenderness at the first and second lumbar vertebrae. Routine laboratory examination was normal except for an increased sedimentation rate and a tuberculin skin test of + +. X-ray examination of the chest was negative, but roentgenograms of the lumbar spine revealed an area of destruction in the anterior portion of the body of the second lumbar vertebra which was called by the roentgenologists a malignant destructive lesion, probably a myeloma.

Aspiration biopsy was done and smear and cultures proved to be positive for tubercle bacilli (Figs. 4-A and 4-B).

CASE 3. Mrs. A. J. H., a white female, forty-eight years old, entered the Hospital on January 8, 1946, with the complaint of backache for sixteen months. There was no history of trauma. Three days before admission, while she was lifting a bucket of water, the pain had become excruciating and radiated down the right lower extremity. The patient was confined to bed. Physical examination showed chiefly tenderness in the right sacro-iliac joint. The routine laboratory examination was entirely negative. Roentgenographic examination revealed a cystic area in the body of the second lumbar vertebra with slight compression. The roentgenographic report was that this process was definitely not malignant and could be found in actinomycosis or in treated Hodgkin's disease. Aspiration biopsy of this area was done, but no diagnosis could be made, since the material obtained was chiefly blood.

The patient signed out of the Hospital to be readmitted a year later; at this time there was a gibbus at the first and second lumbar vertebrae. Aspiration biopsy this time brought out tissue which was diagnosed in the pathology laboratory as angio-endothelioma.

It should be noted that on this aspiration only a small amount of tissue was obtained. The tumor cells were demonstrated in one small portion of the slide and could easily have been missed by the pathologist (Figs. 5-A and 5-B).

CONCLUSIONS

Aspiration biopsy of the spine is a valuable although not an infallible method of

obtaining a diagnosis in obscure lesions of the spine. It must be remembered that, since small bits of tissue are obtained through a partially blind approach, a negative diagnosis in many cases simply indicates a failure to aspirate pathological tissue and does not necessarily imply an absence of pathology. The pathology laboratory should not be criticized for simply reporting what is seen on the slides.

It is suggested that the procedure be used more widely—together with laboratory, clinical, and roentgenographic aids in obscure cases. More than ordinary caution should be exercised to observe the rules of surgical technique, judgment, and interpretation. The anatomy of the spine should be kept in mind and the technique which has been developed through trial and error should be followed carefully. We believe that, if the patient has been anaesthetized, he will be subject to less hazard from possible injury to vital parts. If possible, the unhappy experience of losing tissue after it has been extracted must be avoided by careful labeling and cooperation with the pathology department and the laboratories.

A small but interesting series of cases have been observed. In many of these cases, diagnosis, at least in our hands, would not have been possible had we not been able to examine the tissue directly obtained from the pathologically involved area.

REFERENCES

Robertson, R. C., and Ball, R. P.: Destructive Spine Lesions. Diagnosis by Needle Biopsy. J. Bone and Joint Surg., **17**: 749–758, July 1935.

Valls, José; Ottolenghi, C. E.; and Schajowicz, Fritz: Aspiration Biopsy in Diagnosis of Lesions of Vertebral Bodies. J. Am. Med. Assn., **136**: 376–382, 1948.

DISCUSSION

Mangle and Severe Wringer Injuries of the Hand in Children

(*Continued from page 63*)

dominal pedicle flaps, and he reported excellent results in all cases with a 40 per cent. reduction in hospitalization. Since localized burns of the hand present little or no problem of generalized shock, immediate excision and grafting greatly reduces the period of immobilization, eliminates absorption from granulating areas, and should prove to be the preferred method of treatment for localized burns of the hand.

a. Braithwaite, F., and Watson, J.: Some Observations on the Treatment of the Dorsal Burn of the Hand. British J. Plastic Surg., **2**: 21–31, 1949.

b. Ross, W. P. D.: The Treatment of Recent Burns of the Hand. British J. Plastic Surg., **2**: 233–253, 1950.

Dr. William H. Frackelton, Milwaukee, Wisconsin: In the mangle injury there is not only the crushing factor but also the tearing factor, as well as the contusion. There is a tearing of the vascular network between the subcutaneous tissue and the underlying fascia. Therefore, we are faced with an arm and hand on which there is, in effect, a sleeve of damaged pedicle skin graft. No wonder slough is so much a part of the picture.

Dr. Posch (closing): A cervical sympathetic block should be of aid in reducing the swelling in severe injuries. In addition, one could consider the use of hyaluronidase. This would also probably aid in decreasing the oedema. We know of one instance where it was used with remarkable effect.

Once the granulating area has been covered with a split-thickness graft, the question arises as to when the final full-thickness graft may be applied. We allow the graft to contract the maximum amount. This usually takes from six to eight weeks. We rarely wait longer than this, because in a growing child there is a tendency for deviation of the digits to occur, especially if the contracture is on one side of the finger. It is important, as Dr. Phalen emphasized, that adequate dressing be applied to the hands of these children. A large compression dressing, which extends from the finger tips to the upper arm, should be applied. Unless this is fastened securely with safety pins and adhesive tape, it will surely become loose. We have had this happen to us on several occasions. However, with adequate fastening the dressings will remain intact.

I wish to thank the discussors for their interest in this important problem and for their excellent suggestions on the care and management of these severe injuries and burns.

ROENTGENOGRAPHIC EXAMINATION OF THE LUMBOSACRAL SPINE IN ROUTINE PRE-EMPLOYMENT EXAMINATIONS

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For many years it has been a universal experience in industrial and compensation medical practice that one of the most costly disabilities, as well as a disability resulting in great loss of time, is low-back strain and its variations and sequelae. Until comparatively recently little has been done to find a solution to this problem. During the past few years, however, many of the larger and heavier industries have been paying more attention to this problem, and recently several papers have appeared reporting the results of pre-employment roentgenographic surveys of the lumbosacral spine. The reader's attention is called to a paper of Marsh and Rombold whose survey included 572 roentgenographic examinations, and to that of Colcher and Hursh whose series consisted of 1,500 roentgenographic examinations. The reasons for offering the present study are: (1) There has been much less written on this subject than its importance to industry would seem to warrant; and (2) the present series consisting of 4,654 roentgenographic examinations of the lumbosacral spine should be a valuable addition to the statistics of the subject.

This survey was begun January 1, 1951, and the present series includes the findings of a two-year period ending December 31, 1952. The advantages in making such a survey include, first, the reduction of losses from a compensation point of view by the refusing of employment to persons to whom the Company has no obligation by virtue of previous employment and who have spine defects which represent a definite risk of future claims. It is also an advantage, in the case of those persons for whom an obligation to employ exists, to have a record of pre-existing spine defects in case of future injury. Second, in the case of persons who are employed with spine defects, the pre-employment examination allows the intelligent placing of them in positions which involve less risk or otherwise limit their activity. Third, from the individual's point of view, it has been possible to advise those who were refused employment because of spine defects that it would be safer for them to seek employment of a less arduous nature. Since this policy was put into practice, roentgenographic examinations of the lumbosacral spine have been made in all candidates for employment who had not previously worked in the plant and also in all employees who were rehired after a period of absence and who had not had a roentgenographic examination of the spine during the preceding year. The routine followed consisted in the making of anteroposterior and lateral roentgenograms on fourteen-by-seventeen-inch film and a coned lateral roentgenogram of the lumbosacral joint on ten-by-twelve-inch film. The cassettes used had an intensifying screen and a Potter-Buckey diaphragm.

During the first year in the operation of this policy, persons who had some defects of the spine were still hired, and the attempt was made to place them in favored employment or otherwise to limit their activity. However, it became increasingly difficult to do this for several reasons. In the first place, the Company is engaged in heavy industry—the manufacture of Diesel-electric locomotives and medium tanks for the Army—and the opportunities for favored employment are naturally limited. Secondly, most of the production work in the plant is done by means of a system of cooperative piece work. Under this plan it is necessary for an individual employee to be physically capable of doing any of several jobs, especially if the employee wishes to advance to a higher rate of pay.

For these reasons, the policy was adopted during the second year of the plan of the rejection for employment of all persons with spine defects who were without seniority gained by previous employment and whose spine defects fell in the following categories:

1. Acquired defects, such as fractures, disc abnormalities, pantopaque in the neural canal, and previous spine fusions;

2. Osteo-arthritic (hypertrophic) changes of any degree;

3. All defects involving the lumbosacral joint, including such conditions as all varieties of transitional vertebrae and spondylolisthesis;

4. Abnormal curvatures of marked degree;

5. Miscellaneous defects, such as tumors.

It is felt that all of these defects either represent a weakness of the spinal architecture or predispose the applicant to possible injury, thus becoming the basis of claims for permanent disability compensation. Other defects, such as osteo-arthritic changes (even though the changes were previously asymptomatic), may become activated by back strain and become the basis of claims. A certain number of persons with spine defects are accepted for employment. These include for the most part men with such defects as scoliosis of a mild degree, neural-arch defects (spina bifida occulta) unless extensive, absence of the twelfth rib, and a rudimentary rib on the first lumbar vertebra. It is felt that these defects are of little clinical significance in that they ordinarily do not predispose the employee to back strains nor are they activated by back strains.

The over-all results of the survey can be summarized as follows:

Number of spine roentgenograms made	4,654
Number with normal findings	3,180
Number with a single defect	1,148
Number with multiple defects	326
Number of applicants rejected because of roentgenographic findings	430

In addition to the number shown above, an additional thirty-one persons were rejected because of a history of back injury or ailment, although they had negative roentgenographic findings. When these are included, it will be seen that approximately 10 per cent. of all applicants were rejected because of spine defects. For the reasons previously stated, the majority of the rejections occurred during the second year of the survey. It is also obvious that many persons were hired in spite of defects, for the most part because of seniority established by previous employment in the plant. The total number of rejections for all causes, including not only spine defects but also such conditions as hernia, severe varicose veins, and chest disorders, amounts to approximately 20 per cent.

In the analysis of the defects found, the following classification was devised:

I. Congenital and developmental defects.
  A. Regional shift of vertebrae.
    1. Caudad shift (lumbarization of the first sacral vertebra).
      a. Complete.
      b. Incomplete.
    2. Cephalad shift (sacralization of the fifth lumbar vertebra).
      a. Bilateral.
      b. Unilateral (hemisacralization).
  B. Extra segment (lumbar or sacral).
    1. Normal (fully developed) segment.
    2. Transitional segment.
  C. Epiphyseal defects,—that is, failure of union of centers in the vertebral bodies.
  D. Neural-arch defects (spina bifida occulta).
  E. Scoliosis (including only cases with rotation of bodies).

FIG. 1-A

FIG. 1-B

Fig. 1-A: Lateral roentgenogram shows anterior displacement of the third lumbar vertebra on the fourth lumbar vertebra in a man sixty-one years old. The displacement was probably not traumatic in origin.

Fig. 1-B: Same case. Anteroposterior view of displacement.

II. Displacement and dislocation of vertebral bodies.
   - A. Spondylolisthesis (the fifth lumbar vertebra over the first sacral vertebra).
   - B. Other.
     1. Lateral displacement of the fifth lumbar vertebra on the first sacral vertebra.
     2. Lateral displacement of the fourth lumbar vertebra on the fifth lumbar vertebra.
     3. Anterior displacement of the third lumbar vertebra on the fourth lumbar vertebra (Figs. 1-A and 1-B).

III. Traumatic and degenerative changes.
   - A. Osteo-arthritis (all degrees).
   - B. Fracture.
     1. Vertebral bodies.
     2. Transverse processes.
   - C. Compression and wedging of vertebral bodies without definite evidence of fracture.
   - D. Disc abnormalities.
     1. Narrowing of disc space.
     2. Complete loss of disc space.
        - a. With fusion of adjacent bodies.
        - b. Without fusion.

IV. Surgical abnormalities.
   - A. Pantopaque in the neural canal.
   - B. Spine fusion.

TABLE I

EXAMINATIONS BY AGE GROUPS

Age Group	Examinations (*No.*)	Examinations (*Per cent.*)	Defects (*No. of Men with*)	Defects (*Per cent. of Men with*)
18 to 29	1,488	32.0	286	19.3
30 to 39	1,366	29.4	329	24.1
40 to 49	951	20.4	383	40.2
50 to 59	569	12.2	303	53.2
60 and over	280	6.0	173	62.0
Totals	4,654	100.0	1,474	

V. Miscellaneous defects.

A. Hemangioma of a vertebral body.

B. Osteochondroma of a vertebral body.

C. Osteochondritis of the eleventh thoracic vertebra.

D. Marked asymmetry of the lumbosacral joint or sacrum not falling in any other classification.

The presence of certain defects in this classification on the one hand and the absence on the other hand of certain other defects which could normally be expected to occur in a series such as this requires explanation. While this is for the most part an etiological classification, it is not intended to include all the possible variations and defects to which the human spine is subject. Only those conditions are included which were felt to have clinical or statistical significance. For example, under *I.*, *C.* are included only epiphyseal defects of the vertebral bodies. Defects of the transverse processes or rudimentary ribs on the first lumbar vertebra are not included, because it was felt that they have no significance either as a cause of symptoms or in relation to possible back strain. In a few applicants, the presence of a rudimentary rib on the first lumbar vertebra was helpful in the determination of the status of a transitional vertebra, that is, whether it represented a caudad or a cephalad shift. In all cases of applicants in whom epiphyseal defects of transverse processes were found, the fact was noted on the individual employee's record to preclude the possibility, in case of future injury, of the mistaking of this variation for a fracture of a transverse process.

Again, it will be noted that our classification outline and statistical tables do not include asymmetrical lower lumbar and sacral facets. Southworth and Bersack reported a series of 550 persons subjected to roentgenographic examination of the upper gastrointestinal system. The vertebral column findings in these roentgenograms were analyzed.

TABLE II

CAUDAD SHIFT*

(Lumbarization of the First Sacral Vertebra)

Age Group	Complete (*No.*)	Complete (*Per cent.*)	Incomplete (*No.*)	Incomplete (*Per cent.*)
18 to 29	3		9	
30 to 39	0		12	
40 to 49	2		2	
50 to 59	0		3	
60 and over	0		1	
Totals	5	0.10	27	0.58

* There were thirty-two cases of lumbarization, an incidence of 0.68 per cent.

TABLE III

CEPHALAD SHIFT *
(Sacralization of the Fifth Lumbar Vertebra)

Age Group	Hemisacralization		Bilateral Sacralization	
	(*No.*)	(*Per cent.*)	(*No.*)	(*Per cent.*)
18 to 29	50		60	
30 to 39	46		40	
40 to 49	25		26	
50 to 59	11		17	
60 and over	6		16	
Total	138	2.75	159	3.41

* There were 297 cases of sacralization, an incidence of 6.16 per cent.

These authors found asymmetry of the fourth and fifth lumbar facets in 26.5 per cent., asymmetry of the fifth lumbar and first sacral facets in 17.4 per cent., and asymmetry of the facets of either or both articulations in 36.4 per cent. All of these patients were asymptomatic as regards the back. It is doubtful, therefore, that this variation bears any relation to low-back instability. This, coupled with the high percentage of incidence of asymmetrical facets, would make it uneconomical to reject these persons for employment, as has been advocated by some. For this reason we have disregarded this condition. The 3,180 examinations reported as having normal findings probably include 25 or 30 per cent. with asymmetrical facets.

Classification *II* which includes spondylolisthesis and other malalignments of vertebral bodies was not included under either developmental or traumatic conditions, because, almost without exception, it has been impossible to determine the etiology of these conditions in this series. All persons in this group were asymptomatic both as regards the past and the present, and none gave a history of trauma.

An analysis of the detailed statistical tables follows.

Table I shows the total number of roentgenographic examinations divided into the age groups 18 to 29, 30 to 39, 40 to 49, 50 to 59, and 60 and over. The majority of our applicants fall in age groups under forty. The same table also shows the number of persons by age groups with defects of the spine found on roentgenographic examination. As one would expect, there is a progressively greater incidence of defects with advancing age, from 19.3 per cent. in the youngest group to 62 per cent. in the oldest group. By far the greatest cause of this increase is the incidence of osteo-arthritic changes.

Table II shows a breakdown of the instances of shift of spinal characteristics about the lumbosacral joint in a caudad direction, — that is, the sacral vertebrae taking on varying characteristics of the lumbar vertebrae. There were five cases of complete lumbarization of the first sacral vertebra. In the affected persons there were six normal-appearing lumbar vertebrae and four sacral segments. Most of the spines, however, showed an angulation between the fifth lumbar and the sixth lumbar vertebrae less than, but similar to, the normal angulation at the lumbosacral joint. Incomplete lumbarization varied from the presence of a disc between the bodies of the first and second sacral vertebrae to almost complete separation, although all vertebrae showed wide wing-shaped transverse processes. The total percentage of the incidence of lumbarization of the first sacral vertebra was 0.68 per cent. which is at variance with the findings of Southworth and Bersack who found an incidence of 2 per cent. Allen and Lindem found 0.56 per cent.

Table III shows the occurrence of sacralization of the fifth lumbar vertebra. This has been divided into unilateral (hemisacralization) and bilateral sacralization. Hemisacralization on the right and on the left was not recorded statistically. The criterion used in the determination of sacralization was the actual fusion of one or both transverse processes

TABLE IV

EXTRA SEGMENTS *

Age Group	Normal (*No.*)	Normal (*Per cent.*)	Transitional (*No.*)	Transitional (*Per cent.*)
18 to 29	4		3	
30 to 39	1		1	
40 to 49	4		1	
50 to 59	0		0	
60 and over	0		0	
Total	9	0.19	5	0.1

* There were fourteen cases of extra segments, an incidence of 0.29 per cent.

to the sacrum. Cases of widened, wing-shaped transverse processes on the fifth lumbar vertebra without actual fusion are not included. Hemisacralization is, of course, easy to determine. Bilateral sacralization is in some cases more difficult. In most cases it was possible to make the determination by the counting of the number of sacral and coccygeal segments and by the noting of the characteristics of the first lumbar and the twelfth thoracic vertebrae, such as the presence or absence of rudimentary ribs on the first lumbar vertebra. However, in a few cases it was necessary that the entire spinal column be included in the roentgenogram and that the examiner count down from the cervical region in order to determine whether he was dealing with a sacralized fifth lumbar vertebra or a normal first sacral vertebra. The total percentage of incidence of sacralization was 6.16 per cent. with a greater number being unilateral. Giles found an incidence of 9.2

FIG. 2-A

FIG. 2-B

Fig. 2-A: Lateral roentgenogram shows double vertebra at the fifth lumbar level with duplicated processes in a man twenty-five years old.

Fig. 2-B: Same case. Anteroposterior view of double vertebra.

TABLE V

Age Group	Epiphyseal Defects of the Vertebral Bodies	Neural-Arch Defects
18 to 29	10	82
30 to 39	20	38
40 to 49	6	11
50 to 59	1	10
60 and over	1	3
Total	38 (0.81 per cent.)	144 (3.09 per cent.)

per cent., but his series included cases of wide transverse processes as well as actual fusion.

In Table IV is shown the incidence of extra segments in the lumbosacral region. Here again it was necessary in some cases that the entire spine be included in the roentgenogram in order to determine whether an extra segment was present or whether the defect consisted of a caudad or a cephalad shift. Under the classification of normal extra segments are grouped spines with either six lumbar and five sacral segments or five lumbar and six sacral segments. However, these must have normal-appearing individual vertebrae. There were nine of these altogether—an incidence of 0.19 per cent. Under the classification of transitional extra segments are four spines having five lumbar and five sacral segments and a transitional segment between the two areas. This group also includes one spine with a large fifth lumbar vertebra made up of the fused bodies of two vertebrae with duplicated transverse and spinous processes (Figs. 2-A and 2-B). The total incidence of extra segments in the lumbosacral area is 0.29 per cent.

Table V shows, in the first column following the age groups, the occurrence of failure of fusion of epiphyseal centers in one or more vertebral bodies. In the majority of the affected applicants, only one vertebra was involved; and in a greater number, the upper anterior border of the vertebral body was involved. The incidence in this series is 0.81 per cent.

The next column shows the occurrence of neural-arch defects or spina bifida occulta. No attempt was made to separate statistically the varying degrees of the defect found or to note the location. Most of these defects were found in the first sacral vertebra, however, with a lesser number in the fifth lumbar vertebra or in both the fifth lumbar and the first sacral vertebrae. The incidence in this series is 3.09 per cent, which disagrees markedly with the findings of Southworth and Bersack who found an incidence of 18.2 per cent.

In Table VI are shown the cases of scoliosis found. Only cases of demonstrable rotation of the vertebral bodies are included. It will be observed that the lowest incidence of scoliosis occurs in the 30 to 39 age group. With this exception, there is an increasing inci-

TABLE VI

SCOLIOSIS WITH ROTATION

Age Group	No. of Cases	Incidence (*Per cent.*)
18 to 29	28	1.88
30 to 39	19	1.39
40 to 49	20	2.10
50 to 59	24	2.63
60 and over	17	6.07
Total	108	2.32

TABLE VII

SPONDYLOLISTHESIS

Age Group	No. of Cases	Incidence (*Per cent.*)
18 to 29	29	1.94
30 to 39	28	2.04
40 to 49	20	2.10
50 to 59	15	2.63
60 and over	5	1.78
Total	97	2.08

dence from 1.88 per cent. below thirty to 6.07 per cent. over sixty. It would seem that the obvious conclusion evident in these statistics is that an appreciably greater number of cases of scoliosis occur with advancing age and the repeated small traumata of daily life than occur as developmental defects in adolescence.

The occurrence of spondylolisthesis is presented in Table VII. The variation of incidence with respect to age appears to be haphazard, the variation being from a low of 1.78 per cent. in the age group over 60 to a high of 2.63 per cent. in the age group 50 to

TABLE VIII

OSTEO-ARTHRITIS

Age Group	No. of Cases	Incidence (*Per cent.*)
18 to 29	15	1.0
30 to 39	140	10.24
40 to 49	295	31.01
50 to 59	275	48.33
60 and over	169	60.35
Total	894	19.20

59. The other age groups fall somewhere in between. Practically all of the people with spondylolisthesis were asymptomatic and gave no history of trauma. In view of this fact and the small variation of incidence in different age groups, it would seem that the inference can be drawn that the majority of cases of spondylolisthesis occur early in life and remain asymptomatic for many years. The degree of spondylolisthesis found varied from the smallest detectable malalignment of the posterior borders of the adjacent verte-

TABLE IX

TRAUMATIC AND DEGENERATIVE CHANGES

	Fracture		Compression and Wedging of the Vertebral Bodies (*No. of Cases*)
Age Group	Vertebral Bodies (*No. of Cases*)	Transverse Processes (*No. of Cases*)	
18 to 29	6	1	9
30 to 39	8	1	11
40 to 49	6	1	10
50 to 59	5	0	11
60 and over	0	0	9
Total	25 (0.53 per cent.)	3 (0.06 per cent.)	50 (1.07 per cent.)

TABLE X

INTERVERTEBRAL-DISC ABNORMALITIES

Age Group	Narrowing of Disc Space (*No. of Cases*)	Complete Loss of Disc Space Without Fusion (*No. of Cases*)	Complete Loss of Disc Space With Fusion (*No. of Cases*)	Total No. of Cases	Incidence (*Per cent.*)
18 to 29	9	7	2	18	1.20
30 to 39	10	6	4	20	1.46
40 to 49	23	7	2	32	3.36
50 to 59	13	7	7	27	4.74
60 and over	9	5	7	21	7.50
Total	64	32	22	118	2.53

bral bodies to instances in which from one-third to one-half of the width of the body was malaligned. The total incidence is 2.08 per cent. This is somewhat less than the incidence found by Allen and Lindem whose series showed an incidence of 2.96 per cent.

Table VIII shows the incidence of osteo-arthritic changes. These changes include all degrees from minimal hypertrophic spurring of one or two vertebrae to almost complete bridging and fusion of most of the lower thoracic and lumbar vertebrae. This group obviously represents by far the greatest proportion of increased incidence of defects with advancing age. The occurrence of osteo-arthritic changes varied from 1.0 per cent. in the 18 to 29 age group to 60.35 per cent. in the age group over 60. These findings are comparable to those of Colcher and Hursh who found 3 per cent. in a group with an average age of 25.3 years. Southworth and Bersack found 13 per cent. under forty and 60 per cent. over forty in a group of patients with scoliosis, and 9.3 per cent. under forty and 48.1 per cent. over forty in a non-scoliotic group of patients. In the present series no attempt has been made to keep statistics regarding accompanying lesions, although the impression was gained that hypertrophic changes occurred more frequently in persons with other defects, such as scoliosis and sacralized fifth lumbar vertebrae.

In Table IX are shown other traumatic and degenerative changes of the vertebrae. In the case of the changes shown as fractures of the bodies, a definite fracture line or loss of continuity of the cortex is demonstrable in the roentgenogram. Where no break in the cortex could be demonstrated, the changes are listed as "compression and wedging". The latter probably represent degenerative changes due to repeated small traumata rather than acute trauma. There were only three spines with definite fracture of transverse processes. These had to be carefully differentiated from ununited epiphyses or rudimentary ribs. The criteria adopted for differentiation was irregularity and absence of cortex along the line of separation, displacement of the separated fragment, or both. The incidence of these defects apparently bears no relation to age.

Table X shows the incidence of the disc-space abnormality. This is divided into cases of simple narrowing of disc space and complete loss of disc space, with and without fusion of adjacent vertebral bodies. In the great majority of affected applicants the lumbosacral discs were involved, although in a few, discs higher up were involved. It should be pointed out that the group of defects classed as degenerative disc changes includes only those defects which can be presumed to be primarily changes in the disc itself. The applicants in this group showed normally shaped transverse processes. Many of the applicants with sacralization of the fifth lumbar vertebra showed narrowed or even absent lumbosacral disc spaces. These changes, it is felt, represented an aplastic rather than a degenerative condition and are not included in this group. The over-all incidence of degenerative disc change shown is 2.53 per cent. The occurrence shows a definitely increasing trend with advancing age from 1.20 per cent. in the youngest group to 7.50 per cent. in the group over sixty. Schmorl's nodes are not included in these statistics on the assumption that they have little, if any, clinical significance.

There is no table showing the occurrence of the surgical abnormalities found in this series. Altogether twenty-five persons were shown to have pantopaque in the neural canal, an incidence of 0.53 per cent. In addition, eleven applicants had had surgical fusion of two or more vertebrae, an incidence of 0.23 per cent. No relationship to age was found as, of course, was to be expected.

SUMMARY

1. The findings in 4,654 roentgen examinations of the lumbosacral spine in routine pre-employment examinations are divided into age groups and the incidence of the various abnormalities encountered is correlated with age.

2. Defects which the author feels to be of actual or potential clinical significance and which are demonstrable by roentgenogram were found in 1,174 applicants or 25.44 per cent. of the persons examined.

3. Approximately 10 per cent. of the applicants were rejected for employment because of spine defects. It is both necessary and desirable to accept for employment a certain number of persons with defects of the spine because of the seniority established by prior employment in the plant. However, as time goes on, the tendency is to adopt more rigid standards for acceptance.

4. A program such as this is not a panacea for the problem of compensation claims due to injury or strain of the back. Many injuries will occur in heavy industry to backs not previously the seat of structural defects. However, it is felt that the program will eliminate a number of claims which are based primarily on structural defects. In addition, in the case of those applicants accepted with defects, a record of pre-existing defects will be useful when it is alleged that subsequent injuries are the cause of defects found. For these reasons and as an aid in the placement of persons with spine abnormalities, it is felt that the cost is more than justified.

5. The program will continue and, after a period of years, it should be possible to report on the incidence of subsequent injuries and resultant claims in individuals with and without pre-existing structural defects of various types.

NOTE: It is desired to acknowledge the considerable help in preparing the statistical Tables of Miss Elizabeth Brownell, R.N.

REFERENCES

ALLEN, M. L., and LINDEM, M. C.: Significant Roentgen Findings in Routine Pre-Employment Examination of the Lumbosacral Spine. Am. J. Surg., **80**: 762–766, 1950.

COLCHER, A. E., and HURSH, A. M. W.: Pre-Employment Low-Back X-Ray Survey. A Review of 1500 Cases. Indust. Med. and Surg., **21**: 319–321, 1952.

GILES, R. G.: Vertebral Anomalies. Radiology, **17**: 1262–1266, 1931.

MARSH, H. O., and ROMBOLD, CHARLES: A Practical Solution for the Industrial Back Problem Including X-Ray Examination. Compensation Med., **4**: 21–25, 1952.

SOUTHWORTH, J. D., and BERSACK, S. R.: Anomalies of the Lumbosacral Vertebrae in Five Hundred and Fifty Individuals without Symptoms Referable to the Low Back. Am. J. Roentgenol., **64**: 624–634, 1950.

RELATION OF THE RADIAL NERVE TO THE SHAFT OF THE HUMERUS

BY ROBERT O. WHITSON, M.D., BAYTOWN, TEXAS

The description of the course of the radial nerve in the posterior compartment of the arm as given in textbooks of anatomy is inaccurate, although the illustrations are frequently correct. Anatomists, however, like to believe that their observations coincide with the words of the authorities, blaming apparent incongruities on their technique. The author encountered a specimen which could not possibly be said to follow the accepted description. Later review of a series of cadavera showed that this inconsistency was not an anomaly.

The description of the musculospiral groove and of the course of the radial nerve in the posterior compartment of the arm varies little in four widely used textbooks of anatomy [1, 2, 3, 4]. In *Gray's Anatomy*, for example, the description of the lateral border of the humerus reads: ". . . its center is traversed by a broad but shallow oblique depression, the radial sulcus (*musculospiral groove*)". The description of the anterolateral surface reads: "About the middle of this surface is a rough, triangular elevation, the deltoid tuberosity for insertion of the Deltoideus; below this is the radial sulcus, directed obliquely from behind, forward, and downward, and transmitting the radial nerve and profunda artery." The spiral groove is said to demarcate the lateral and medial heads of the triceps brachii. Conversely, the radial nerve is described as leaving the front of the long head of the triceps, passing between the medial and lateral heads of the triceps, and traversing the posterior compartment of the arm in the spiral groove.

In a dissection undertaken recently* the specimen did not in any way fit the above description. Instead, the radial nerve traversed the triceps at such a depth that it was nowhere in contact with the humerus. The arteria profunda brachii arose from the posterior circumflex humeral artery and approached the radial nerve gradually, producing a shallow, narrow groove on the posterior surface of the humerus. The spiral groove gave origin to fibers of the upper, posterior portion of the brachialis and was some distance from the radial nerve. It was apparent that the separation of the triceps into three heads was artificial and that the medial and lateral heads were in reality a single muscle group traversed by a nerve and an artery.

Later, one arm in each of twenty-four cadavera was carefully dissected and observed.† It was found in every case that the radial nerve, when it left the front of the long head of the triceps, was separated from the humerus by fibers of the medial head of the triceps (Fig. 1). It was difficult to determine accurately the thickness of this portion of muscle. Therefore, the distance from the upper border of the undisplaced nerve to the origin of the muscle fibers deep to the nerve was measured. This was found to measure from one to five centimeters, averaging 3.4 centimeters. As the lateral supracondylar ridge of the humerus was approached, the radial nerve was found to be in contact with the lower margin of the spiral groove for a variable distance, namely, zero to seven centimeters with an average of 3.3 centimeters. The thicker the mass of muscle deep to the nerve, the shorter is the distance over which the nerve lies in direct contact with bone. Distally, the nerve pierces the lateral intermuscular septum and then passes to the surface of the brachialis. One specimen was similar to the original cadaver arm in that there was no contact between the radial nerve and the humerus.

It was apparent again that the division of the "short" portion of the triceps into medial and lateral heads is artificial. If the reflection is carried out subperiosteally from

* Department of Anatomy, Medical College of the State of South Carolina, Charleston, South Carolina.
† Department of Anatomy, The University of Texas Medical Branch, Galveston, Texas. Dr. Donald Duncan, Chairman, gave much helpful assistance and advice.

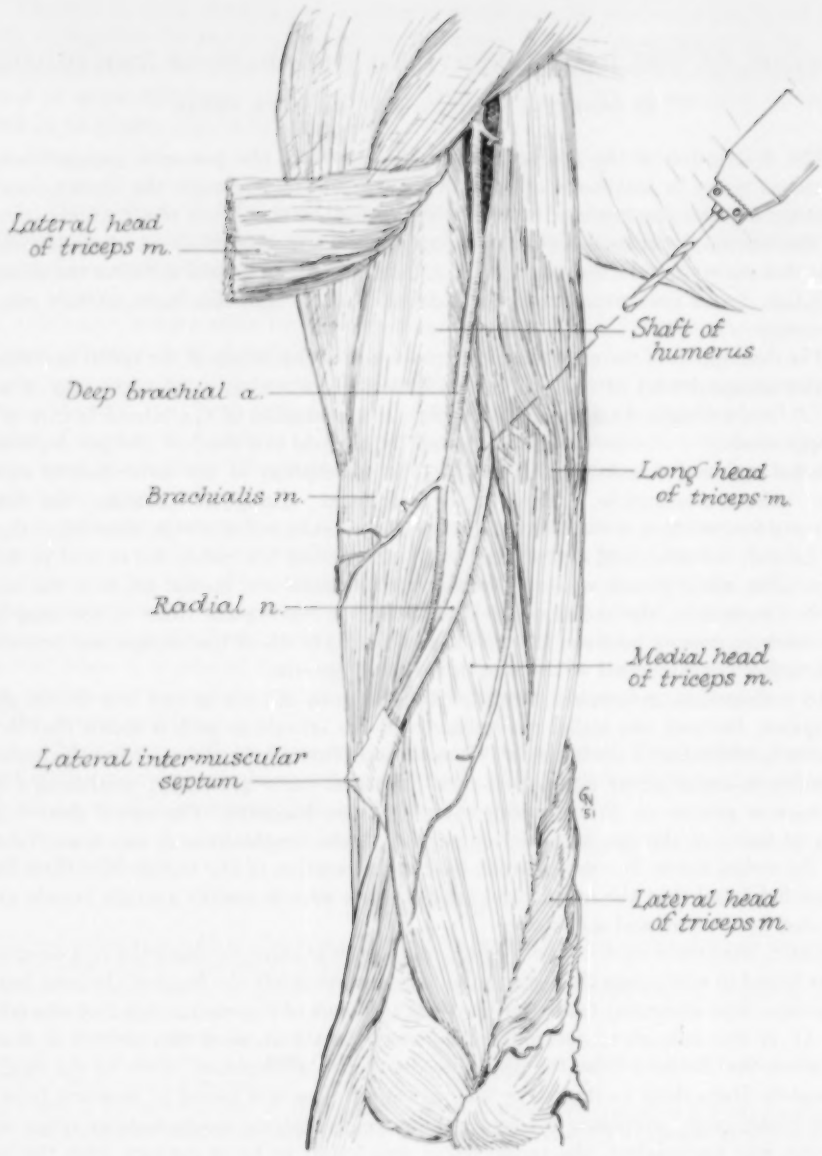

FIG. 1

below upward, one continuous muscle attachment is visualized. The radial nerve traverses this muscle mass in the same way that the posterior interosseous passes through the supinator. Tracing the radial nerve by division of the muscle fibers superficial to it and reflecting these proximally and distally, as is usually done, gives rise to a false impression.

Before the radial nerves in this series were disturbed, the course of each was outlined by several holes in the cortex of the humerus, made with a drill which had been pushed through the underlying triceps. Then, by sharp dissection, the periosteum was elevated and the contours of the bone were inspected. The spiral groove in every specimen gave origin to the uppermost fibers of the brachialis, as is shown in Figure 2. These fibers

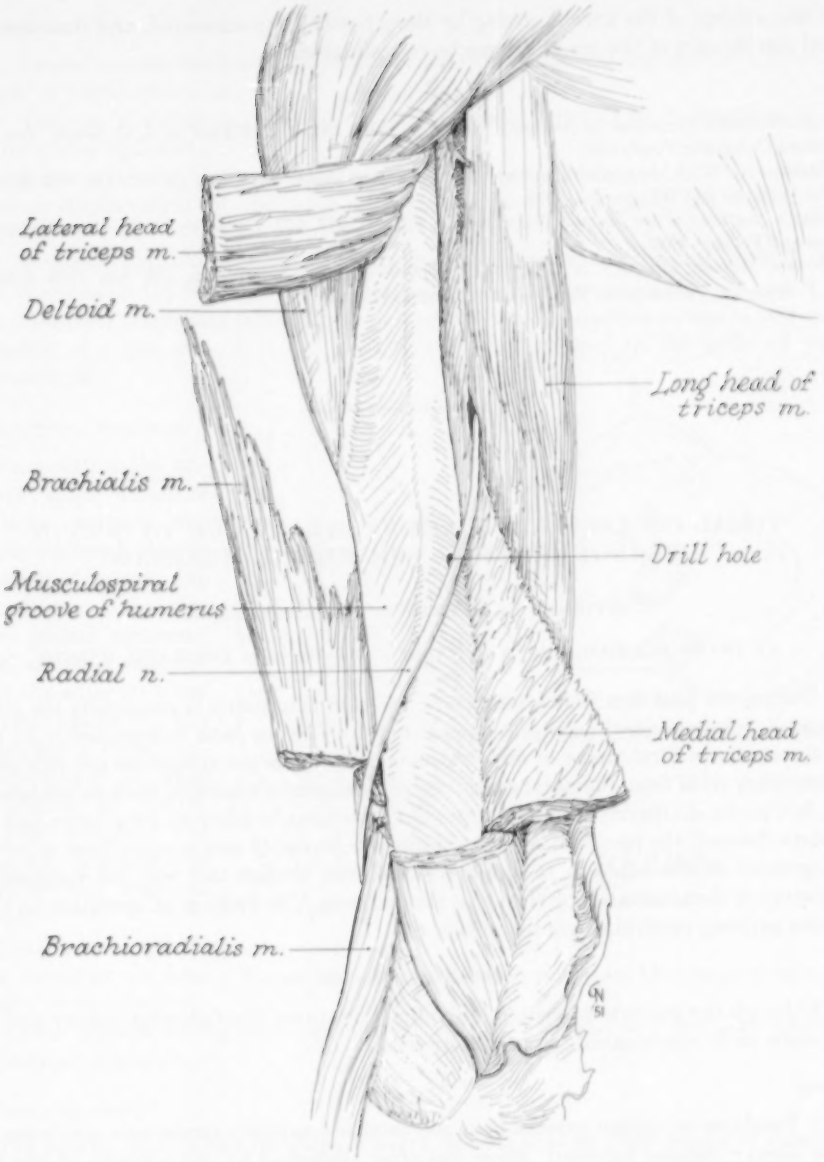

FIG. 2

extend upward posterior to the deltoid tuberosity and are deep to the most lateral tendinous origin of the triceps. The radial nerve lies close to the inferior lip of the spiral groove but never in it. In not quite half of the cadavera the profunda artery was found in a second narrow groove.

The clinical importance of these observations is not great. However, they do offer an explanation for the fact that the radial nerve escapes injury in many fractures of the humerus in which nerve damage would be expected. It is probable, in these cases, that the nerve is protected from the sharp bone edges by a layer of triceps or brachialis muscle. Nevertheless, it is of importance that the anatomy of the arm be described accurately,

that the concept of the triceps arising by three heads be reconsidered, and that the functional significance of the spiral groove be re-evaluated.

REFERENCES

1. Cunningham's Text-Book of Anatomy. Ed. 9, pp. 253, 490, 1081. Edited by J. C. Brash. New York, Oxford University Press, 1951.
2. Grant, J. C. B.: A Method of Anatomy, Descriptive and Deductive. Ed. 5, pp. 104, 119, 123. Baltimore, The Williams and Wilkins Co., 1952.
3. Gray's Anatomy of the Human Body, Ed. 25, pp. 185, 437, 972. Edited by C. M. Goss. Philadelphia, Lea and Febiger, 1948.
4. Morris' Human Anatomy. A Complete Systematic Treatise. Ed. 10, pp. 198, 440, 1106. Edited by J. P. Schaefer. Philadelphia, The Blakiston Company, 1942.

TIBIAL COLLATERAL LIGAMENT STRAIN DUE TO OCCULT DERANGEMENTS OF THE MEDIAL MENISCUS

Confirmed by Operation in Thirty Cases *

BY FRANK B. SMITH, M.D., AND HARRY C. BLAIR, M.D., PORTLAND, OREGON

During the past five years, our experience with fifty patients presenting the clinical picture of "chronic tibial collateral ligament strain" led us each independently to make two observations. First, many of these patients with significant symptoms got only partial or temporary relief from the usual conservative therapeutic measures, such as local radiant heat, hot packs, diathermy, multiple novocain injections, irradiation, long casts, and arch supports. Second, the persistence of symptoms was probably due to some form of internal derangement of the adjacent medial meniscus, even though this was not suggested by the history or demonstrated by the usual clinical tests. The findings at operation on thirty of these patients confirmed our suspicions.

CLINICAL PICTURE

Although the patients presented individual variations, the following history and findings, alone or in combination, were characteristic.

History

1. Insidious or sudden onset of pain and localized exquisite tenderness over some part of the tibial collateral ligament. Sleep was often disturbed by the pressure of one knee against the other;

2. Pain proportionate to weight-bearing activity of the knee;

3. Initiation or aggravation of pain, particularly on weight-bearing in varying degrees of flexion;

4. Initiation or aggravation of pain by jarring of the limb into external rotation as by striking the toe against an object;

5. No swelling or only mild swelling when the symptoms had been of long duration;

6. No related direct or indirect injury;

7. No locking.

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Chicago, Illinois, January 27, 1953.

Examination

1. Tenderness maximal over the center of the tibial collateral ligament or over either its upper or lower attachments;

2. Absence of visible or palpable cartilage beneath, anterior to, or posterior to the tibial collateral ligament;

3. Tibial collateral ligament pain, aggravated in some instances and not in others by lateral displacement of the tibia with its resultant opening of the medial joint space;

4. Increased pain over the region of the ligament in most instances by external rotation of the tibia on the femur with the knee flexed to 90 degrees;

5. Complete temporary relief of pain and tenderness by injection of one to two cubic centimeters of 1 per cent. novocain solution into the ligament at the point of maximal tenderness.

OPERATIVE FINDINGS

At operation the medial joint space of each of the thirty patients was carefully explored. Particular attention was paid to the structure and mobility of the medial meniscus, as well as to its relationship to the adjacent tibial collateral ligament. The relationship of these various structures as they were affected by flexion, extension, rotation, and side-to-side movement of the tibia was observed directly.

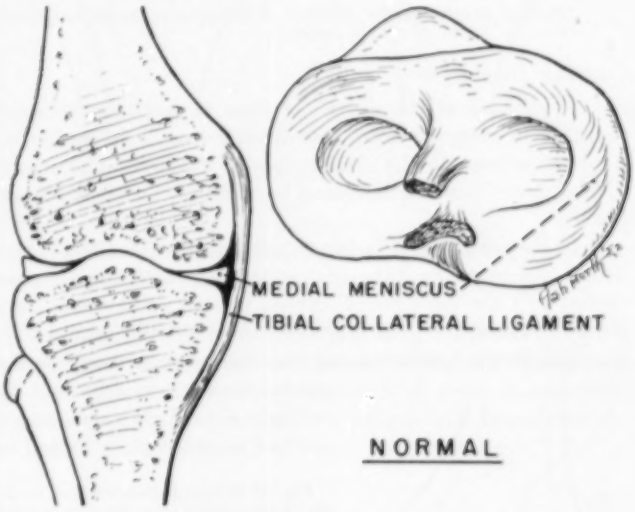

FIG. 1

Normal relation between medial meniscus and tibial collateral ligament.

Derangement of the medial meniscus was demonstrated in every patient. The various types of derangement can be divided into two categories,—cartilage deformity and cartilage displacement.

Cartilage Deformity

The middle third of the cartilage of every patient showed some degree of structural deformity in that its peripheral border had become thickened and of greater height, while the width had decreased. This portion of the cartilage appeared to have mushroomed out of the joint space medially beneath the ligament. Other cartilage deformities in order of their frequency were as follows:

1. Apparent lengthening of the whole cartilage as a result of old healed tears of the anterior or posterior thirds;

2. Apparent overstretching of the anterior or posterior ligamentous attachments of the cartilage without gross evidence of old or recent tear in the cartilage;

3. Recent tear of the anterior or posterior third of the meniscus;

4. Bucket-handle tear;

5. Multiple cysts of the medial meniscus.

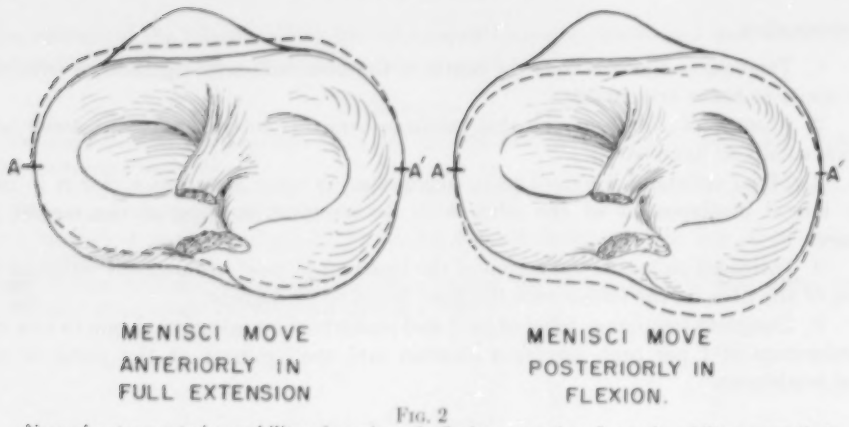

FIG. 2

Normal anteroposterior mobility of meniscus in flexion extension. Lateral mobility normally is minimal. (*A* and *A'* remain constant.)

Cartilage Displacement

Regardless of the degree or type of cartilage deformity, the middle third of the cartilage in every instance was displaced or could easily be displaced out of the medial joint space beneath the tibial collateral ligament. The degree and direction of the medial displacement could be increased by adduction and decreased by abduction in all but two knees.

In the majority of instances, the middle third of the cartilage appeared no longer to fit into the contours of the adjacent medial joint space. Passive closure of the medial joint space, with the knee flexed, caused further displacement and wedging of the peripheral border between the joint space and the overlying ligament. In four patients, the cartilage was completely herniated and was displaced or could be displaced upward between the medial femoral condyle and the adjacent ligament. In six patients, a similarly displaced grossly deformed medial meniscus had become tightly lodged between the ligament and the medial tibial condyle. In one patient, scar tissue held the grossly deformed cartilage tightly wedged beneath the upper portion of the ligament and the adjacent femoral condyle. In another, it was similarly fixed between the ligament and the adjacent medial tibial condyle.

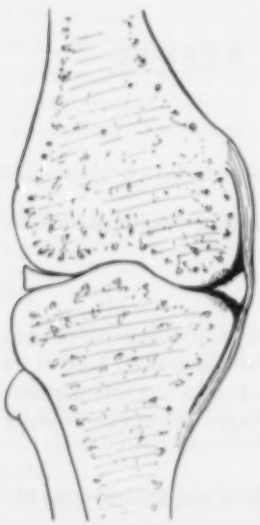

FIG. 3

Fig. 3: Minimal deformity of medial meniscus which is displaced out of the medial joint space on weight-bearing. The meniscus returns to position on cessation of joint compression.

Fig. 4: Further compression deformity and displacement of the medial meniscus. The meniscus no longer fits the contours of the medial joint space. It is unable to return completely to normal position at any time and thus displaces the adjacent tibial collateral ligament.

Fig. 5: The meniscus shows gross deformity and displacement upward between collateral ligament and medial femoral condyle. Part of the cartilage returns to the joint space on cessation of weight-bearing.

Fig. 6: The meniscus shows gross deformity and displacement downward between the tibial collateral ligament and the medial tibial condyle. Part of the cartilage returns to the joint space on cessation of weight-bearing.

Fig. 7: The meniscus may be grossly deformed and fixed in a position of upward displacement between the tibial collateral ligament and the medial femoral condyle.

Fig. 8: The meniscus may be grossly deformed and fixed in a position of downward displacement between tibial collateral ligament and medial tibial condyle.

Fig. 9: Bucket-handle tear with displacement of medial fragment of meniscus out of the joint space beneath the collateral ligament.

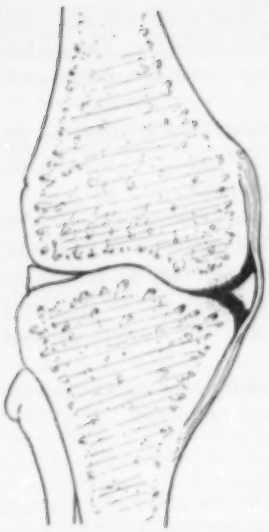

FIG. 4

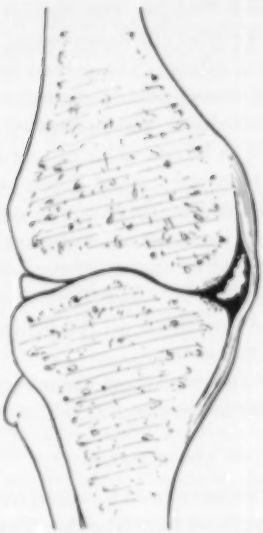

FIG. 5

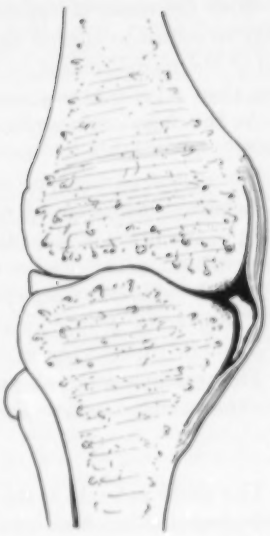

FIG. 6

Treatment and Subsequent Course

Treatment for each patient consisted in removal of the deranged medial meniscus. None of the patients has had recurrence of his symptoms.

DISCUSSION

Normally, the menisci are resilient, compressible structures which add springiness and support to the margins of the joint. Their contours change with position and with movement (Fig. 1). Usually, anteroposterior movement is maximal and lateral movement is minimal (Fig. 2).

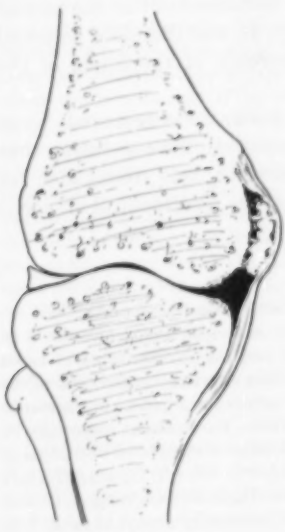

FIG. 7

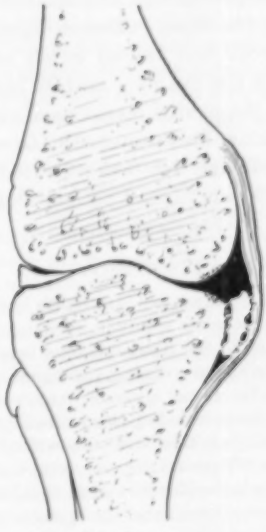

FIG. 8

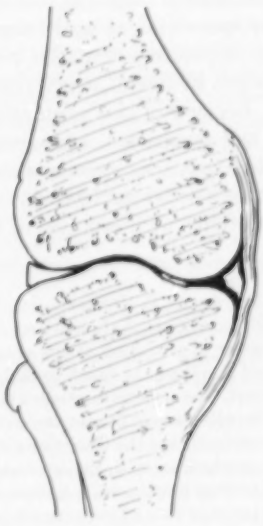

FIG. 9

With the onset of degenerative changes, the menisci lose their elasticity and their ability to return to normal contours after the compression of weight-bearing. The middle third of the medial meniscus, being subjected to greater and more constant compression forces than other portions, is more susceptible to distortion.

As the degenerative changes increase, the deformity increases. The greater the deformity, the less able the meniscus is to return to the medial joint space. Displacement, which is at first partial, becomes more severe and finally is permanent.

Repeated displacement of the middle third of the medial meniscus results in overstretch of the fibers of the adjacent ligament, or irritation of the ligament and its bursa. These changes, which are not detected by the usual clinical tests, give rise, we believe, to the "tibial collateral ligament syndrome". The degree and duration of the syndrome would seem to be proportionate to the effects on the ligament produced by derangement of the middle third of the medial meniscus.

The accompanying schematic drawings show the normal position and mobility of the medial meniscus as well as the various derangements noted in our patients.

END RESULTS

The thirty patients in this series have been followed for one to five years; the average follow-up period has been two years and four months. Twenty-seven patients have been free of their original symptoms; three still have quadriceps atrophy and weakness. These three had all had atrophy of the quadriceps for a considerable period before operation, were operated upon little more than a year ago, and may still regain normal function through diligent quadriceps exercises.

SUMMARY

During the past five years, fifty patients have been seen who presented the clinical picture of "chronic tibial collateral ligament strain".

Although it was not suggested by the history or demonstrated by the usual clinical tests, internal derangement of the medial meniscus was suspected.

Exploration of the knees of thirty patients confirmed the suspicion of derangement. The degree and type of derangement varied from patient to patient, but the symptom-producing mechanism was essentially the same in all. That is, part or all of the middle third of the medial meniscus was deformed as well as displaced or herniated out of the medial joint space and wedged beneath the tibial collateral ligament. It was therefore assumed that displacement of the meniscus had caused either overstretch of the fibers of the adjacent ligament or irritation of the ligament and its bursa.

Because of this assumption the medial meniscus of each patient was removed. None has had recurrence of his symptoms. This would seem to substantiate the conclusion that medial meniscus derangement, though not demonstrated clinically, was responsible for the tibial collateral ligament syndrome in each patient and that the treatment of choice is arthrotomy with removal of the medial meniscus.

DISCUSSION

DR. ALLEN F. VOSHELL, BALTIMORE, MARYLAND: Dr. Smith has presented a series of cases which exemplify conditions that have been brought to our attention more frequently in the past few years, due to an increasing appreciation of the area deep to the tibial collateral ligament and the various types of tissue located there, any of which could be the site of a clinicopathological condition affecting the function of the ligament. The structures referred to are the medial meniscus, the synovial membrane adjacent to the meniscus, the subligament bursae, the areolar tissue including blood vessels and nerves, the ligament (especially its deep surface), and the tibia. Certain changes in these structures will set up a series of symptoms and physical findings which are quite similar, making a differential diagnosis, preoperatively, very difficult. The major feature of all of them would seem to be tenderness in the deep part of the tibial collateral ligament occurring on tension of or pressure into it; yet it would be quite evident that the ligament is not necessarily always at fault. I do not quite agree with Dr. Smith that the condition he has described should be listed under the heading of

strain, especially since no specific injury is involved, yet I can appreciate his explanation that the constant or recurrent stretching of the ligament over the protruding meniscus could slightly stretch the ligament. My analysis of the situation is that repeated passage of the ligament over a prominence sets up an irritation of the under surface of the ligament or its immediately subjacent structures causing a reaction to develop, which might better be termed a fibrositis or a bursitis or both. I speak of this whole group as "the subtibial collateral ligament syndrome", with basic pathological changes being variable as indicated above; this is a little more inclusive than as used by Dr. Smith, but actually I think we are talking along almost identical lines.

I can verify Dr. Smith's reference to the variations in the meniscus itself and the buckling or bulging of it when its attachments have become lax; I have seen this situation a number of times and have relieved the symptoms by excision of the meniscus, even though actual disruption was not detected, and I feel that the procedure is proper provided that the removal is indicated after a careful analysis of the whole clinical picture,—that is, an accurate and complete history, a carefully made and analyzed examination, and failure of a suitable conservative regimen of rest and physical therapy, as described by Dr. Smith. The injection of novocain into the area of tenderness does *not* localize the condition to the ligament itself, as it is almost impossible to prevent the anaesthetic fluid from entering the subjacent space. Also, the injection will relieve the symptoms in almost all types of the syndrome, yet excision of the meniscus will not cure them all. In spite of the present-day attitude that meniscectomy is an innocuous procedure, I would strongly and emphatically state that it can be otherwise and it should be avoided, unless specifically indicated. I am sure I need not expand this point further, but I would like to stress, especially for the younger men, "Be sure before you operate so as not to be sorry afterward". If you will follow this axiom, you will not often be wrong.

Dr. D. H. O'Donoghue, Oklahoma City, Oklahoma: Dr. Smith and Dr. Blair have presented some very thought-provoking ideas in discussing these cases of altered menisci. Those of us who have taken some special interest in the knee joint and, as a result, have operated on many knees and treated non-surgically many more, have, I think, been constantly impressed by the fact that there is very seldom a negative exploration of the knee. I have many times mentioned to my residents and others that we practically always find in the knee joint some pathological changes justifying arthrotomy. If this original premise is correct, it follows that one of two things must be true,—either we are far too conservative in our selection of cases for surgery and are refusing the benefits of surgery to many patients who otherwise might be offered a more favorable prognosis than is given by conservative or non-surgical care, or we are interpreting our findings at surgery as showing abnormal changes which are either non-existent or not primary. I believe that our diagnostic acumen is not accurate enough so that we can be 100 per cent. correct in our decision as to whether or not to operate. Nevertheless, we almost always do find some degree of pathological change in the knee which would seem to justify the operation,—either a loose semilunar cartilage, or a redundant fat pad, or some degree of chondromalacia. It would appear that we are withholding the benefits of surgery from many knees that would profit therefrom, but it behooves us to be very careful that we do not unconsciously fit the pathological findings to the preoperative diagnosis when there is no true causal relation.

The clinical picture presented in this paper certainly is an extremely common one. Findings on examination of tenderness over some portion of the ligament, aggravated by rotation or adduction or abduction of the tibia, plus relief of pain by novocain injection, certainly is almost uniformly present in any situation where there is some degree of sprain of the medial collateral ligament. Indeed, the history as related can be almost always elicited in any case of a sprain of the knee. Obviously, these findings alone are not sufficient to indicate medial meniscus damage. If this were true, it would mean that every case that had had a sprain of the knee or injury to the tibial collateral ligament has had concomitant injury to the medial cartilage sufficiently extensive to justify surgery. Obviously, the authors had some other criterion for damage to the cartilage than that noted in their discussion. Actually, the authors are drawing upon their extensive experience and wise clinical judgment in realizing that they are facing a situation where there is more pathologically than a simple ligament injury. This accounts for the fact that they are able to select thirty cases out of the fifty for surgery and uniformly find a pathological medial meniscus, for I am convinced that, if they had operated in every case which presented the clinical history and findings related, they would inevitably have opened many knees which did not show any damage to that structure.

If the diagnosis is accepted strictly on the basis of history a..d clinical findings, there must of necessity be very many operations which result in disappointment. The symptoms related are significant only if the patient has failed to respond to ordinary non-surgical measures. I would like to emphasize again that meniscus pathology is not the rule in instances of apparently moderate ligament damage, but rather the exception.

Dr. Smith (closing): I should like to thank Dr. Voshell and Dr. O'Donoghue for their comments and criticisms as well as words of approval. I appreciate particularly the suggestion made by Dr. Voshell that the condition which we describe be referred to as a syndrome. This composite clinical picture seems to be characterized by a fairly constant appearance of the essential clinical features and findings which we have enumer-

(*Continued on page 118*)

GROWTH AND DIFFERENTIATION OF THE SKELETON IN THYROIDECTOMIZED-HYPOPHYSECTOMIZED RATS TREATED WITH THYROXIN, GROWTH HORMONE, AND THE COMBINATION*

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INTRODUCTION

The purpose of the following experimental study was to attempt to elucidate the influence of thyroxin and of pituitary growth hormone on skeletal growth and maturation. Clinical observations have established the fact that dwarfism may result from hypofunction of either gland. However, it has been demonstrated experimentally that the two glands are interdependent, removal of the pituitary resulting in atrophy of the thyroid, and removal of the thyroid being followed by hypoplasia of the acidophil cells of the pituitary. Experiments designed to determine the specific roles played by the thyroid and the pituitary in skeletal metabolism by means of surgical removal of one gland and subsequent hormonal replacement therapy have been difficult to interpret because of the presence and possible function of the remaining gland [11,12]. Hence it was felt that removal of both glands as sources of endogenous hormones should afford clearer evidence concerning the influence of each. This report describes the skeletal changes in rats thyroidectomized at birth and hypophysectomized at twenty days of age and their subsequent response to injections of pituitary growth hormone, thyroxin, and a combination of the two.

METHOD

Approximately 300 rats of the Long-Evans strain were thyro-parathyroidectomized on the day following birth, the technique and postoperative care described in previous reports being used [12]. During the postoperative period, the animals were observed for presumptive evidence of effective thyroid deprivation (reduced weight gain, delayed eruption of the incisors, and retarded development of the pinnae). At twenty days of age, the rats judged most likely to be without a thyroid gland were anaesthetized and roentgenograms were made; if skeletal development was found to be sufficiently retarded, the rats were then hypophysectomized by the parapharyngeal route. Subsequently, at thirty days of age, the survivors were anaesthetized and roentgenograms were again made. Those which met the criteria for probably complete thyroidectomy (skeletal age of fifteen days or less at the chronological age of thirty days according to Scow and his co-workers) were selected as suitable for the experiment.

Thirty-one of the original 300 animals were thus selected. Three were sacrificed as onset controls and the remaining twenty-eight were divided into four groups. The first received no treatment; the second received thyroxin; the third, growth hormone; and the fourth, thyroxin and growth hormone. The dosage of thyroxin employed, 2.5 micrograms per day, corresponded to that used in recent experiments with thyroidectomized or hypophysectomized rats [11,12]. The growth hormone was electrophoretically homogeneous and was prepared and standardized as described by Li, Evans, and Simpson. The dosage started at 0.1 milligram per day, injected intraperitoneally, and was raised with increas-

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TABLE I

GROWTH OF RATS THYROIDECTOMIZED AT BIRTH, HYPOPHYSECTOMIZED AT TWENTY DAYS OF AGE, AND TREATED WITH THYROXIN, GROWTH HORMONE, OR THE TWO COMBINED, FROM THIRTY TO SIXTY DAYS OF AGE

Treatment	Rat No.	Body Weight		Body Length		Tibia Length
		At Autopsy (*Grams*)	Gain in 30 Days (*Grams*)	At Autopsy (*Centimeters*)	Gain in 30 Days (*Centimeters*)	At Autopsy (*Millimeters*)
None	G25	35	−12	19.8	1.1	23.0
	G02	33	−6	20.1	1.7	23.3
Thyroxin 2.5 micrograms per day *	BH07	54	19			24.1
	W40	62	9	23.8	4.4	26.6
	BH15	71	32	25.8	8.1	27.5
	GH01	73	25	26.3	7.6	28.8
	GH19	73	23	25.5	5.7	28.8
	BH71 †	59	20	25.5	6.5	28.1
	B77 †	59	22	25.5	6.4	27.0
Growth hormone 0.1 to 2.0 milligrams per day **	BH09	92	53	25.5	8.6	28.7
	W32	79	36	24.3		26.5
	G25	59	16	23.4	4.8	26.8
	BH26	57	27	22.7	6.5	26.6
	B92 †	58	20	22.4	5.8	26.7
Thyroxin and growth hormone	BH10	98	56	28.3		30.6
	W23	144	96	31.3	11.1	31.5
	W69 †	107	65	30.8	11.0	32.1
	G91 †	127	82	31.6	13.1	32.1
	GH88 †	134	90	32.1	13.5	34.0

* BH15, GH01, and GH19 were started on a lower dose, 1.25 micrograms per day, increased to 2.5 micrograms per day by the tenth day.

** G25, BH56, and B92 developed a respiratory infection during the last five to ten days of the experiment, during which time they lost weight.

† "Thyroidectomy" by radio-active iodine (I^{131}).

ing body weight until 2.0 milligrams per day were being given.* When thyroxin and growth hormone were given together, the doses were the same as those specified for the hormones given separately. The treatment was for the thirty-day period between thirty and sixty days of age. The rats were weighed at five-day intervals. At autopsy, their length was measured and roentgenograms were again made. The sella turcica was inspected under the binocular microscope for fragments of pituitary tissue. The completeness of thyroidectomy was determined by dissection of the neck region and was subsequently checked by the radio-autographic technique of Reinhardt. All rats showing any evidence of persisting fragments of either gland were rejected. There remained for analysis two rats without injections, five with thyroxin injections, four with growth-hormone injections, and two injected with both thyroxin and growth hormone. These numbers are obviously inadequate for statistical analysis. Accordingly, the data obtained are being reported for individual animals.

Additional confidence in the findings was gained from the concurrent examination of another group of thyroidectomized-hypophysectomized rats, in which hypophysectomy had been performed after the thyroid had been rendered aplastic by radio-active iodine (I^{131}) by the technique of Goldberg and Chaikoff. The ages and methods of treatment had been identical with those in the surgically thyroidectomized group. Six such rats

* The dosage of growth hormone was increased on the following schedule: 0.1 milligram, three days; 0.2 milligram, three days; 0.4 milligram, two days; 0.8 milligram, six days; 1.0 milligram, five days; 2.0 milligrams, eleven days.

TABLE II

NORMAL DEVELOPMENTAL EQUIVALENTS OF BODY WEIGHT AND LENGTH AND TIBIA LENGTH OF SIXTY-DAY-OLD RATS THYROIDECTOMIZED AT BIRTH, HYPOPHYSECTOMIZED AT TWENTY DAYS OF AGE, AND TREATED FOR THIRTY DAYS WITH THYROXIN, GROWTH HORMONE, OR THE TWO COMBINED

	Age of Normal Rats of Equivalent Dimensions			
Treatment	Body Weight (*Days*)	Body Length (*Days*)	Tibia Length (*Days*)	Skeletal Maturation (*Days*)
None	18	22	21	17 to 18
Thyroxin	24 to 30	29 to 34	24 to 36	40 to 50
Growth hormone	25 to 35	27 to 33	30 to 36	16 to 18
Thyroxin and growth hormone	36 to 54	38 to 50	44 to 48	40 to 50

were available for study: two treated with thyroxin, one with growth hormone, and three with the two hormones combined. The response of these rats to the various experimental regimens corresponded so closely to that of the group in which surgery had been performed that they provided substantial confirmation. In the tabulation of data, they are identified by a symbol following the animal number.

RESULTS

Growth

Both of the uninjected rats lost weight (Table I). The rats injected with growth hormone gained weight. Those injected with thyroxin also gained weight, although not so much as those injected with growth hormone.* The animals injected with both hormones showed weight gains exceeding those of either of the preceding groups and even approached the gains of normal animals. The body length of the rats injected with thyroxin and of those injected with growth hormone exceeded that of the uninjected controls by three to six centimeters. The body length of the rats injected with both hormones exceeded that of the controls by eight to twelve centimeters.

The length of the tibia corresponded to the body length. The controls had the shortest bones. The rats with thyroxin injections and those with growth-hormone injections had tibiae of greater length than the controls, but not significantly different from each other. The longest bones were found in rats injected with both hormones.

The ages at which normal rats have dimensions like those of the experimental animals

* The gains made by the rats treated with growth hormone were not so great as had been hoped. This is due in part to the lesser responsiveness to growth hormone of thyroidectomized animals as compared to those hypophysectomized [12]. An important factor, however, was the general condition of the animals. Those treated with thyroxin maintained better health and were more resistant to respiratory infections than those receiving growth hormone alone. The untreated thyroidectomized-hypophysectomized rats were the least resistant and showed the greatest group mortality.

In an experiment now being prepared for publication by this laboratory, thyroxin was administered to hypophysectomized rats for a year to demonstrate the limits to which it would stimulate growth. Although slight gains in body weight and length occurred initially, they were not sustained beyond the first six weeks of treatment.

FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

Figs. 1 through 5: Central sagittal sections of proximal end of tibia of sixty-day-old rats. (× 5, hematoxylin and eosin stain.)

Fig. 1: Normal control.

Fig. 2: Uninjected thyroidectomized-hypophysectomized control.

Fig. 3: Thyroidectomized-hypophysectomized and treated with thyroxin from the thirtieth to the sixtieth day of age.

Fig. 4: Thyroidectomized-hypophysectomized and treated with growth hormone for the same period.

Fig. 5: Thyroidectomized-hypophysectomized and treated with thyroxin and growth hormone for the same period.

are shown in Table II. The untreated thyroidectomized-hypophysectomized rats were most retarded in growth, the thyroxin-treated and the hormone-treated rats were less retarded, and the rats treated with both were only slightly retarded.

Differentiation

The skeletal ages of the rats were determined from whole-body roentgenograms. At a chronological age of twenty days (the age at the time of hypophysectomy), the skeletal age of all the rats was twelve to fifteen days. At thirty days of age, when injections began, the skeletal age had advanced to fourteen to sixteen days. During the next thirty days, the uninjected rats showed little advance in skeletal maturation and at sixty days of age their skeletal age was only seventeen to eighteen days. The skeletal age of rats injected

with growth hormone for thirty days was the same as that of the rats without injections. On the other hand, the skeletal age of the rats injected with thyroxin, alone or with growth hormone, for the thirty-day period was forty to fifty days at autopsy.

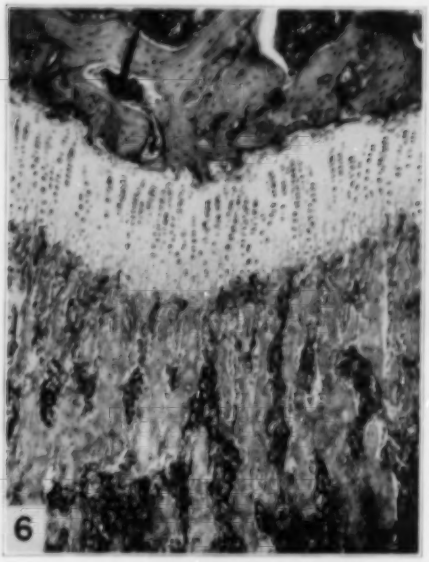

FIG. 6

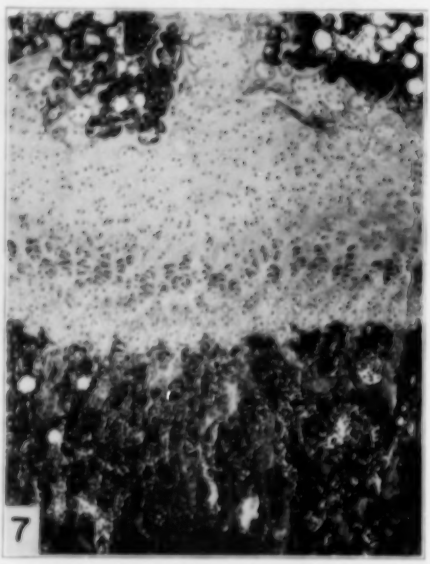

FIG. 7

Figs. 6 through 10: Proximal epiphyseal cartilaginous plates of tibia of sixty-day-old rats. (× 32.5, hematoxylin and eosin stain.)

Fig. 6: Normal control.

Fig. 7: Uninjected thyroidectomized-hypophysectomized control.

Fig. 8: Thyroidectomized-hypophysectomized and treated with thyroxin from the thirtieth to the sixtieth day of age.

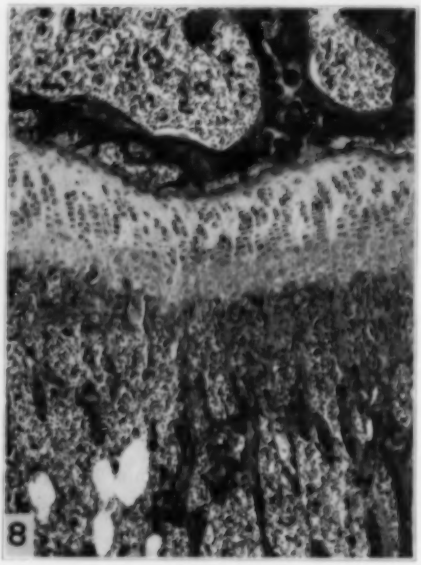

FIG. 8

Histological Studies

The proximal epiphysis of the tibia was studied histologically to afford a basis for comparison between this and previous studies on endochondral osteogenesis following thyroidectomy or hypophysectomy alone. In addition, an attempt was made to express the histological differentiation of the epiphysis attained in the various groups in a quantitative fashion. It was impossible to employ the usual technique of measuring the width of the epiphyseal cartilaginous plate, since in many of the animals the ossification center had not developed sufficiently to establish an epiphyseal disc. As an alternative, the outline of the entire epiphysis (in medial sagittal sections) was traced at a magnification of 17.5. A planimeter was then used to measure (1) the total area outlined and (2) the area occupied by the ossification center within the epiphysis. The percentage of the total area occupied by the ossification center was then calculated. Typical sections of this bone are illustrated at low magnification in Figures 1 to 5, and the epiphyseal plates are shown at higher magnification in Figures 6 to 10.

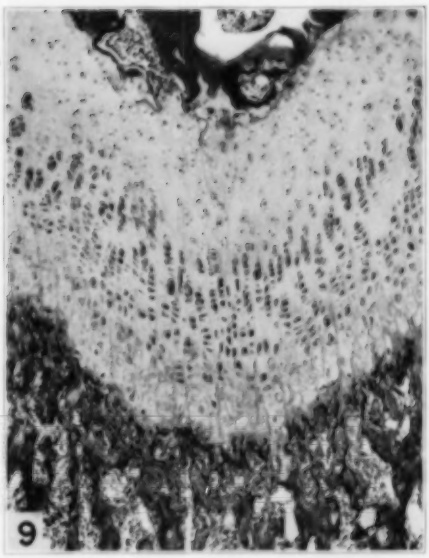

FIG. 9

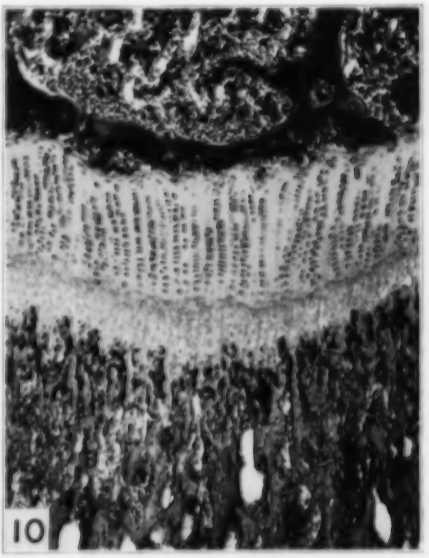

FIG. 10

Fig. 9: Thyroidectomized-hypophysectomized and treated with growth hormone for the same period.
Fig. 10: Thyroidectomized-hypophysectomized and treated with thyroxin and growth hormone for the same period.

The proximal tibial epiphyseal ossification center of the normal sixty-day-old rats was fully expanded and cartilage was found only at the articular surface and in the epiphyseal plate (Fig. 1). The percentage of the epiphysis occupied by the ossification center (57 to 67 per cent.) formed a standard for judging the extent of retardation or advance of differentiation in the experimental animals.

In the untreated thyroidectomized-hypophysectomized rats, the tibia was small and its ossification center was incompletely developed, occupying only 32 to 36 per cent. of the area of the epiphysis (Fig. 2). Structurally, this center contained very little bone; the marrow was predominantly adipose. In the region of the epiphyseal cartilage, most of the chondrocytes were small (Fig. 7). Only a few clusters of flattened proliferating cells were seen. Near the marrow, the cartilage cells were less enlarged and vacuolated than normal. The vascularity was lost at the marrow junction, and the trabeculae of bone were sparse and truncated.

In the thyroxin-treated rats, the tibia was only slightly larger than that in the untreated thyroidectomized-hypophysectomized rats (Fig. 3). The ossification center was fully developed (72 to 76 per cent. of the epiphysis), the cartilage being reduced to an articular surface and an epiphyseal plate. The center had a thin osseous periphery and contained cancellous bone and cellular marrow. In the epiphyseal cartilaginous plate, some evidence of chondrogenesis was seen (Fig. 8) and the chondrocytes next to the diaphysis were somewhat enlarged. Eroding marrow tufts were abundant and a moderate number of bone trabeculae appeared in the marrow cavity.

In the rats injected with growth hormone the epiphysis was larger than the epiphysis of the uninjected rats, but expansion of its ossification center (35 to 46 per cent.) was incomplete (Fig. 4). The epiphysis differed from that of the uninjected rats chiefly in an increased cellularity of the marrow and in a layer of bone next to the epiphyseal cartilaginous plate. At higher magnification (Fig. 9), marked evidence of chondrogenesis was seen, the cells toward the diaphysis being arranged into orderly longitudinal rows. The zone of vacuolated cells was wide, and the cells themselves were enlarged. The diaphyseal marrow cavity was abundantly filled with bone trabeculae.

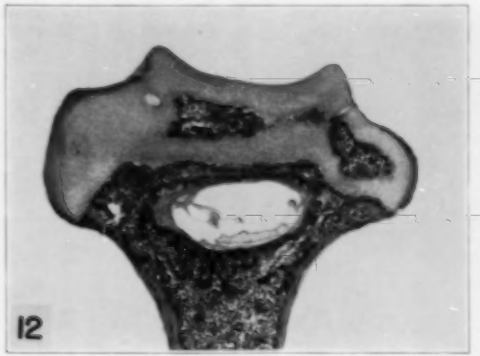

FIG. 13

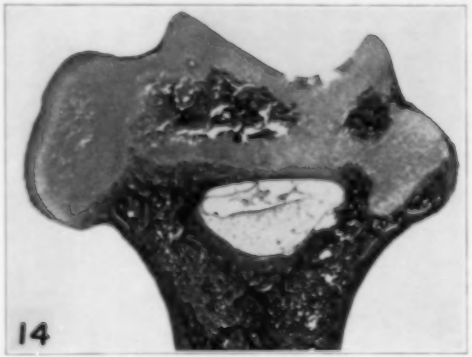

FIG. 14

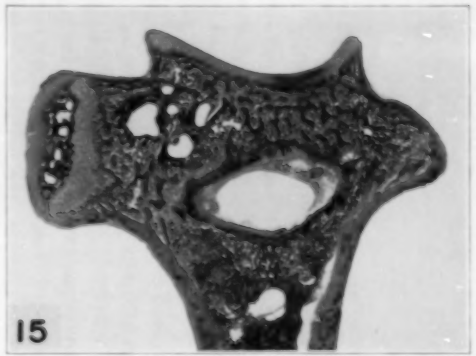

FIG. 15

Figs. 11 through 15: Posterior central sections in the frontal plane of the distal end of the humerus of sixty-day-old rats. (× 5, hematoxylin and eosin stain).

Fig. 11: Normal control.

Fig. 12: Uninjected thyroidectomized-hypophysectomized control.

Fig. 13: Thyroidectomized-hypophysectomized and treated with thyroxin from the thirtieth to the sixtieth day of age.

Fig. 14: Thyroidectomized-hypophysectomized and treated with growth hormone for the same period.

Fig. 15: Thyroidectomized-hypophysectomized and treated with thyroxin and growth hormone for the same period.

In the rats injected with growth hormone and thyroxin, the tibia was large and the ossification center was fully developed, occupying 61 to 72 per cent. of the total area (Fig. 5). It contained cellular marrow and cancellous bone and had a well developed osseous rim. The epiphyseal cartilaginous plate showed evidence of orderly and active chondrogenesis, erosion, and osseous replacement (Fig. 10). The plate was somewhat wider than that in the normal bone (Fig. 6), but otherwise no significant differences were seen.

The distal end of the humerus was selected for histological study because so many of the significant changes in its normal development occur during the ages of critical interest in the present experiment (fifteen to forty days). The main ossification center (capitulum-trochlea) usually appears at fifteen to eighteen days of age and fuses with the diaphysis by forty days of age. Consequently, in normal sixty-day-old rats, no vestige of the cartilaginous plate remains (Fig. 11). In the medial epicondyle a separate ossification center appears between twenty and twenty-five days of age and fuses with the epiphysis shortly after 100 days of age. At sixty days of age, a separate center is present, and active endochondral ossification results in marked projection of the epicondyle.

The humerus of an uninjected thyroidectomized-hypophysectomized rat showed that although the main epiphyseal ossification center had been established, the medial epicondylar region remained cartilaginous (Fig. 12). Its development resembled that of a normal rat between fifteen and twenty days of age and offered confirmation of the skeletal ages assigned to these rats in Table II. It appeared to be an inactive epiphysis, even though very immature in development.

In thyroxin-treated rats, the main epiphyseal ossification center was fully developed and epiphyseal closure was virtually complete, only fragments of the cartilaginous plate remaining (Fig. 13). The cartilaginous plate of the medial epicondyle was perforated prematurely. The incidence of such perforations in the group was variable and the figure illustrates the median response.* The precocious maturation suggested a developmental age even more advanced than the skeletal age of forty to fifty days given in Table II. It is noteworthy that as a result of the premature arrest of growth in the epicondyle it was truncated rather than of normal prominence.

In rats treated with growth hormone (Fig. 14) the humerus, although large, had only an incompletely expanded ossification center in the capitulo-trochlear area, such as was seen in the thyroidectomized-hypophysectomized controls. Again, this immaturity confirmed the skeletal age of sixteen to eighteen days arrived at roentgenographically. The size increase was almost entirely in the cartilage.

In the humerus of rats treated with both hormones, the main ossification center had fused with the diaphysis (Fig. 10). That of the medial epicondyle remained separate and its cartilaginous plate appeared to be active. As a result, the epicondyle corresponded closely in size and differentiation to that seen in the normal sixty-day-old rat. As in the thyroxin-treated rats, variability in the status of the medial epicondyle was found within the group. The illustration represents the majority response.

DISCUSSION

It is apparent that in derangements of skeletal growth two physiologically distinct processes must be differentiated: abnormalities of size as measured by length and diameter of the bones, and abnormalities of maturation as determined by the appearance of the centers of ossification and their subsequent fusion (bone age).

A study of the data presented in Table II and of the histological sections of the tibia and humerus reveals that growth and skeletal maturation were equally retarded following

* Of a total of seven rats treated with thyroxin, two had intact medial epicondylar plates, two had perforated plates, and three showed complete epiphyseal closure.

the combination of thyroidectomy and hypophysectomy. Thyroxin injections produced marked maturation and only moderate growth in the absence of endogenous pituitary and thyroid hormones. In contrast, injections of pituitary growth hormone produced a definite increase in body weight and skeletal dimensions, but did not produce skeletal maturation. Administration of both hormones to the animals with both operations restored the coordination between skeletal growth and maturation.

It has been reported [1] that hypophysectomized rats are able to continue skeletal differentiation for some time following operation, the actual advance being equal to approximately three weeks of normal differentiation, regardless of the age at hypophysectomy. Since there is evidence [9] that some thyroid function persists in hypophysectomized animals, it is probable, from the present experiment, that this accounts for the advance in skeletal age. It is also probable that endogenous thyroxin persists in the tissues for approximately two to three weeks following thyroidectomy, since skeletal maturation ceases approximately eighteen days after removal of the gland [12,14,16].

Although skeletal maturation continues for a limited period of time following hypophysectomy, a decrease in the number and size of the intramedullary trabeculae (osteoporosis) occurs almost immediately [12]; this is a change which cannot be interpreted merely as cessation of growth. It is possible that this may be due to the unantagonized action of the adrenal cortical steroids on the skeleton. Injections of adrenocorticotropic hormone (ACTH) or of cortical steroids in normal rats have resulted in retardation of body growth, with inhibition of both chondrogenesis and osteogenesis [2,5,8]. ACTH injected simultaneously with growth hormone in hypophysectomized rats inhibited the growth-promoting effects of the latter [3]. Injections of ACTH in intact as well as in hypophysectomized rats had no appreciable effect on skeletal maturation [19].

It should be noted that dwarfism may be produced either by failure of normal skeletal growth or by premature skeletal maturation. The latter has been induced in normal [20], in hypophysectomized [11], and in thyroidectomized rats [12] by thyroxin injections and in thyroidectomized-hypophysectomized rats in the present study. Clinically, both estrogen and testosterone have been used in an attempt to accelerate skeletal maturation. Experimental evidence to support such attempts, however, is lacking. Although testosterone will stimulate growth in the normal animal, injections in the absence of the pituitary have had no effect on bone growth [17], with the possible exception of the os penis [21]. Testosterone apparently has no effect on skeletal maturation in the normal or castrate rat [22]. Injections of estrogen in the normal rat are followed by an increase in the intramedullary bone and a decrease in the width of the epiphyseal cartilage, changes which could be due either to stimulation of osteogenesis or to inhibition of resorption and remodeling [23]. However, these changes have not been observed following hypophysectomy [6] and it has been concluded that in the rat*, at least, the effects of estrogen injections on the skeleton are mediated through the pituitary.

No attempt has been made in this discussion to minimize the importance of the parathyroid hormone in skeletal metabolism. However, the absence of the parathyroids in thyro-parathyroidectomized rats apparently is well tolerated, provided the diet is high in calcium. Except for a brief period at the time of weaning, there was no evidence of hypocalcaemic tetany.

REFERENCES

1. Asling, C. W.; Walker, D. G.; Simpson, M. E.; and Evans, H. M.: Differences in the Skeletal Development Attained by Sixty-Day-Old Female Rats Hypophysectomized at Ages Varying from Six to Twenty-eight Days. Anat. Rec., **106**: 555–564, 1950.
2. Becks, Hermann; Simpson, M. E.; Li, C. H.; and Evans, H. M.: Effects of Adrenocorticotropic Hormone (ACTH) on the Osseous System in Normal Rats. Endocrinology, **34**: 305–310, 1944.

* A discussion of the suitability of the rat as an experimental animal in studies of skeletal growth is included in the recent review by Simpson, Asling, and Evans.

3. Becks, Hermann; Simpson, M. E.; Marx, Walter; Li, C. H.; and Evans, H. M.: Antagonism of Pituitary Adrenocorticotropic Hormone (ACTH) to the Action of Growth Hormone on the Osseous System of Hypophysectomized Rats. Endocrinology, **34**: 311–316, 1944.
4. Goldberg, R. C., and Chaikoff, I. L.: A Simplified Procedure for Thyroidectomy of the Newborn Rat without Concomitant Parathyroidectomy. Endocrinology, **45**: 64–70, 1949.
5. Ingle, D. J.; Higgins, G. M.; and Kendall, E. C.: Atrophy of the Adrenal Cortex in the Rat Produced by Administration of Large Amounts of Cortin. Anat. Rec., **71**: 363–372, 1938.
6. Kibrick, E. A.; Simpson, M. E.; Becks, Hermann; and Evans, H. M.: Effects of Crystalline Estrin Implants on the Tibia of Young Hypophysectomized Female Rats. Endocrinology, **31**: 93–96, 1942.
7. Li, C. H.; Evans, H. M.; and Simpson, M. E.: Isolation and Properties of the Anterior Hypophyseal Growth Hormone. J. Biol. Chem., **159**: 353–366, 1945.
8. Moon, H. D.: Inhibition of Somatic Growth in Castrate Rats with Pituitary Extracts. Proc. Soc. Exper. Biol. and Med., **37**: 34–36, 1937.
9. Morton, M. E.; Perlman, I.; Anderson, Evelyn; and Chaikoff, I. L.: Radioactive Iodine as an Indicator of the Metabolism of Iodine. V. The Effects of Hypophysectomy on the Distribution of Labeled Thyroxine and Diiodotyrosine in Thyroid Gland and Plasma. Endocrinology, **30**: 495–501, 1942.
10. Ray, R. D.; Evans, H. M.; and Becks, Hermann: Effect of the Pituitary Growth Hormone on the Epiphyseal Disk of the Tibia of the Rat. Am. J. Pathol., **17**: 509–528, 1941.
11. Ray, R. D.; Asling, C. W.; Simpson, M. E.; and Evans, H. M.: Effects of Thyroxin Injections on Growth and Differentiation of the Skeleton of Hypophysectomized Female Rats. Anat. Rec., **107**: 253–263, 1950.
12. Ray, R. D.; Simpson, M. E.; Li, C. H.; Asling, C. W.; and Evans, H. M.: Effects of the Pituitary Growth Hormone and of Thyroxin on Growth and Differentiation of the Skeleton of the Rat Thyroidectomized at Birth. Am. J. Anat., **86**: 479–516, 1950.
13. Reinhardt, W. O.: Method for Determining Completeness of Thyroidectomy Using Radioactive Iodine. Proc. Soc. Exper. Biol. and Med., **50**: 81–84, 1942.
14. Salmon, T. N.: Effect of Thyro-Parathyroidectomy in New Born Rats. Proc. Soc. Exper. Biol. and Med., **35**: 489–491, 1936.
15. Scow, R. O., and Simpson, M. E.: Thyroidectomy in the Newborn Rat. Anat. Rec., **91**: 201–226, 1945.
16. Scow, R. O.; Simpson, M. E.; Asling, C. W.; Li, C. H.; and Evans, H. M.: Response by the Rat Thyro-Parathyroidectomized at Birth to Growth Hormone and to Thyroxin Given Separately or in Combination. I. General Growth and Organ Changes. Anat. Rec., **104**: 445–463, 1949.
17. Simpson, M. E.; Marx, Walter; Becks, Hermann; and Evans, H. M.: Effect of Testosterone Propionate on the Body Weight and Skeletal System of Hypophysectomized Rats. Synergism with Pituitary Growth Hormone. Endocrinology, **35**: 309–316, 1944.
18. Simpson, M. E.; Asling, C. W.; and Evans, H. M.: Some Endocrine Influences on Skeletal Growth and Differentiation. Yale J. Biol. Med., **23**: 1–27, 1950.
19. Simpson, M. E.: Unpublished data.
20. Smith, E. E., and McLean, F. C.: Effect of Hyperthyroidism upon Growth and Chemical Composition of Bone. Endocrinology, **23**: 546–552, 1938.
21. Thyberg, W. G., and Lyons, W. R.: Androgen-Induced Growth of the Os Penis of Hypophysectomized-Gonadectomized Rats. Proc. Soc. Exper. Biol. and Med., **69**: 158–161, 1948.
22. Turner, H. H.; Lachmann, Ernest; and Hellbaum, A. A.: Effect of Testosterone Propionate on Bone Growth and Skeletal Maturation of Normal and Castrated Male Rats. Endocrinology, **29**: 425–429, 1941.
23. Urist, M. R.; Budy, A. M.; and McLean, F. C.: Species Differences in the Reaction of the Mammalian Skeleton to Estrogens. Proc. Soc. Exper. Biol. and Med., **68**: 324–326, 1948.

HEMANGIOMATA OF THE TENDON SHEATH

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Hemangiomata of one type or another are occasionally encountered in the hand, although they are not among the most frequent types of tumors seen. Hemangioma of the tendon sheath is considerably less common. Geschickter and Keasbey, in 1935, reported only forty of their 570 cases of hemangioma in the forearm, hand, and fingers; two of these were hemangiomata of the tendon sheath. Harkins, in 1937, collected twenty-three cases from the literature, including sixteen from Burman and Milgram's report, and added one of his own. Since that time one additional case has been reported by Webster and Geschickter. The present report adds three more.

From a survey of the cases reported by Harkins, who included a summary of the entire literature, all the data recorded indicated that: fourteen occurred in the first three decades of life; eight in the next three; twelve occurred in females, while only seven occurred in males; thirteen occurred in the upper extremities (equally divided between right and left); seven in the lower extremities (five in the left and two in the right). Apparently this unusual tumor does not show a predilection for one side of the body rather than another [5]. In the author's series all occurred in the upper extremities; two were in males aged sixteen and forty respectively; the third was in a female aged forty-one; two involved the right hand and one the left wrist.

A great deal of confusion concerning the nature of tumors of the tendon sheath exists in the literature. Howard has drawn attention to the early descriptions of the synovial lining of tendon sheaths and has pointed out that the synovial lining is not an epithelialized structure but a specialized connective-tissue surface. This structure lines all open joints, with the exception of articular surfaces, and forms the lining of tendon sheaths.

The division of tumors of the tendon sheaths in the literature is quite confusing. Most authors attempt to classify these tumors by the predominating cell [4,6,7]. King pointed out that, since all these tumors arise from the synovial membrane, the basic cell is the same and their various gross and microscopic appearances are due to the predominating cell structures closely associated with the tissues adjacent to the true synovial covering. Thus such terms as angioma, arborizing lipoma, endothelioma, myeloma, fibroma, and others of the tendon sheaths appear in the literature. It is entirely possible that all these tumors which arise from the same basic cell merely represent an age period in the growth of this tumor [5,7,11]. However, the cases which we are presenting seem to fit all the descriptions of hemangioma.

Boyd described a hemangioma as a "tumor consisting of new formed blood vessels". Frequently, however, it is difficult to say if a collection of blood vessels is a true neoplasm or merely a dilatation of previously existing vessels. Two true forms of hemangioma are recognized: the capillary and the cavernous. Capillary hemangioma consists of a network of capillaries filled with blood. The lining cells, which are large and swollen, may be several layers in depth or they may be very small and sometimes they contain no blood. These cells may proliferate to such an extent that they obliterate the lumen, and the tumor then represents an endothelioma. The cells may be arranged in whorls, especially those around the large blood vessels. According to Boyd, "It has . . . been shown that the first stage in the formation of vascular spaces from the mass of proliferating cells is the development within each cell of a vacuole, which gradually enlarges until the entire cell becomes flattened. In many of the cells the wall gives way so that the vacuoles coalesce, and new blood spaces are thus formed."

Hemangiomata of the tendon sheath are usually painless. Symptoms consist of a soft swelling, which is compressible and which changes either when the limb is elevated and

a tourniquet is placed above the mass or when direct pressure is applied over the tumor mass itself. Some of these tendon-sheath tumors, if they lie close to the surface of the skin, may present a bluish discoloration. Roentgenographic examinations frequently reveal multiple calcified phleboliths. In the cases reported more than 90 per cent. showed evidence of phleboliths [5,8,12].

The treatment of these tumors is entirely surgical. With careful wide dissection these tumors seem to be completely removed and many feel that recurrence is rare [5,8,9].

CASE REPORTS

Case 1. L. H., a white male, forty-six years of age, was examined on February 6, 1950. He was a sheet-metal worker. He stated that as long as he could remember there had been a "sore spot" between the heads of the first and second metacarpals. On December 20, 1949, the patient had caught his hand between a sheet of steel and a wall. The steel slipped and caught his hand between the bottom edge of this steel and the top edge of another piece. Following this the small nodule in the palm of his hand slowly increased in size and became more painful.

Physical examination was essentially negative except for the palm of the left hand. Finger motion, wrist motion, supination, pronation, and elbow and shoulder motions were normal. There were no sensory changes in the fingers or in the other areas of the palm of the hand. Radial and ulnar pulsations were normal. Blood pressure was 126 systolic, 80 diastolic in both arms. In the palm of the left hand between the first and second metacarpals, just below the distal crease of the hand, there was a large tender swelling, measuring 2.5 centimeters in diameter. It was elevated from the palm at a distance of one centimeter. It was semimovable and seemed to move on flexion of the index and second fingers.

Laboratory findings were within normal limits. The Kahn test was negative.

Operation: On February 18, 1950, under general anaesthesia, the field was prepared with soap and water and painted with an antiseptic. The hand was elevated and an Esmarch bandage was placed from the tips of the fingers to the elbow. A blood-pressure cuff was placed above the forearm and the Esmarch bandage was then released.

An incision was made in the distal fold of the palm and was deepened down to the palmar fascia. The subcutaneous tissue about the tumor mass was not discolored. It was dissected back and in the subcutaneous tissue a round, fairly movable bluish mass, 2.5 centimeters in diameter, was encountered. This was freed without difficulty. The proximal portion of the cyst contained a stringlike band which extended to the palmar fascia and through a small defect. The palmar fascia was carefully opened and the attachment of the stringlike mass was found to be joined to the tendon sheath of the index finger. A portion of the tendon sheath was removed. The wound was closed in layers without drainage. The patient returned to the ward in good condition.

The relief from pain was immediate. Sutures were removed on the sixth postoperative day. The patient has had active motion since the operation, and the wound healed well.

Pathological Examination: The specimen consisted of a small cystic mass 2.5 by one centimeters in diameter. It was bluish in color and covered with a well developed membrane. When this was opened, a cystic cavity was discovered filled with non-coagulated blood and some old blood clots.

Microscopic Examination: The section showed the outer layer of the cystic mass to be composed of dense connective tissue, not apparently muscular tissue. On the inner surface there was a growth composed predominantly of connective tissue and dilated blood vessels, with marked hemosiderin deposits. The blood vessels were lined with an endothelial layer with no definite wall. Between the vascular channels there was connective tissue in which the cells were slightly foamy and showed some palisading.

The diagnosis was hemangioma of the tendon sheath.

The patient was examined in June 1952. He had continued working at his trade as a sheet-metal worker without interruption. The scar on the palm of his left hand was soft, pliable, nearly invisible, and not attached to underlying tissue. Finger and hand motions were all present and normal. There was no evidence of recurrence of the tumor. Mr. L. H. was re-examined in April 1953, prior to leaving the state permanently. Nothing new could be determined at that time.

Case 2. Mrs. K. L. A., a forty-year-old white female, was examined on April 19, 1950. She was an office worker and had no history of trauma to the hand. She presented herself complaining of a tumor mass between the third and fourth fingers of the right hand, just distal to the crease of the palm of the hand. The tumor mass was slightly movable and had been painful. During the past three weeks she had noticed a slight bluish discoloration over the tumor.

Physical examination was essentially negative except for the palm of the right hand. Finger motion, wrist motion, pronation, supination, and elbow and shoulder motions were normal. There were no sensory changes in the fingers or in the other areas of the palm of the hand. Radial and ulnar pulsation were both normal. Blood pressure was 120 systolic, 80 diastolic in both arms. On the palm of the right hand, between

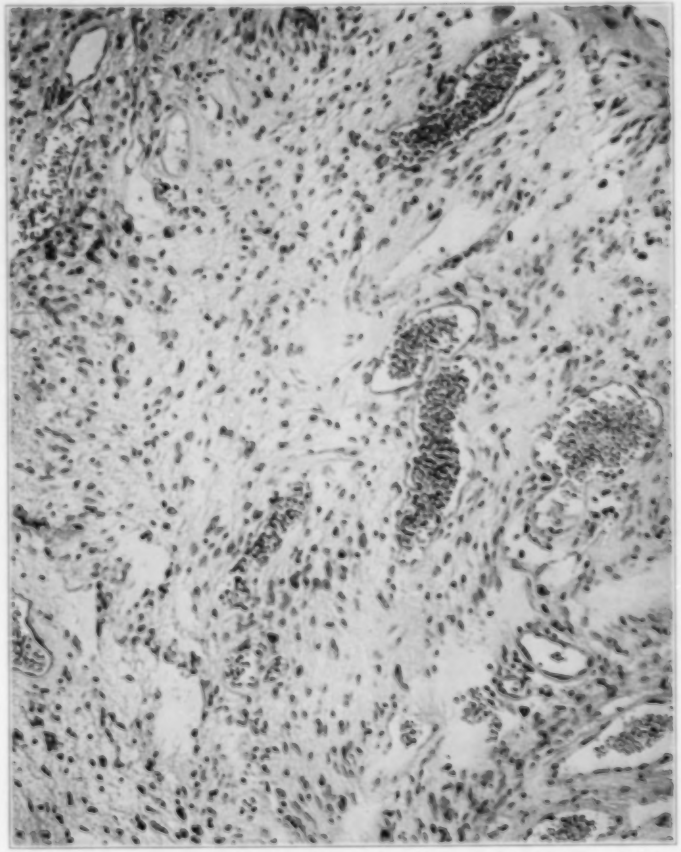

FIG. 1

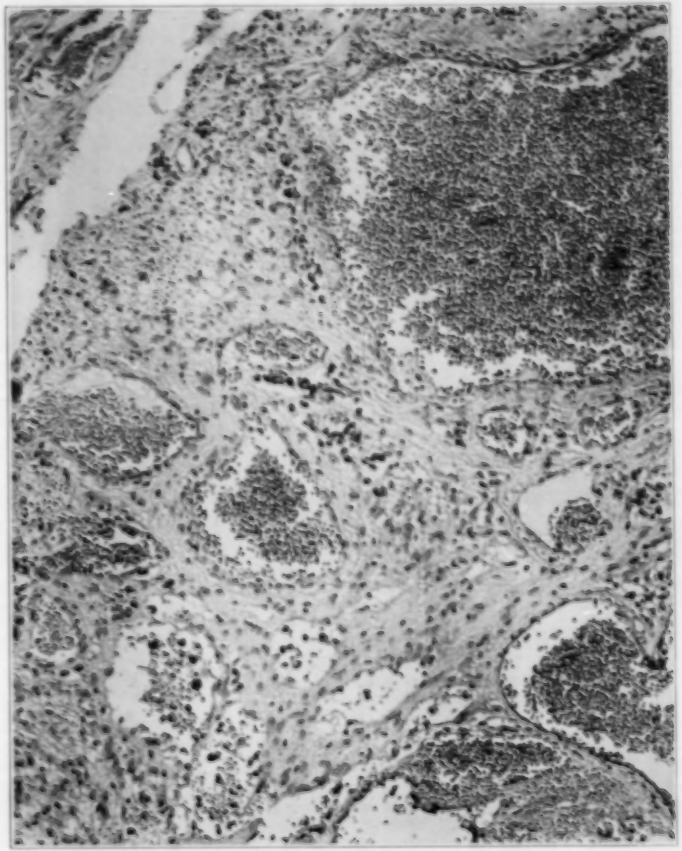

FIG. 2

Fig. 1 (× 450), Case 1; Fig. 2 (× 450), Case 2; and Fig. 3 (× 400), Case 3: Photomicrographs of representative sections of the tumors removed in each of the cases. Note the endothelium-lined cavities containing blood.

the heads of the third and fourth metacarpals, just distal to the distal crease of the palm of the hand, there was a tumor mass measuring two centimeters in diameter. It was elevated from the palm of the hand approximately five millimeters. It was semimovable and was seen to move on extension and flexion of the ring and small fingers of the right hand. The tumor diminished in size on elevation of the hand, but did not disappear completely. Upon application of a rubber bandage, however, it disappeared almost completely. Application of a tourniquet, just tight enough to impede the venous return, caused the tumor to increase in size. Laboratory findings were entirely within normal limits and the Kahn test was negative.

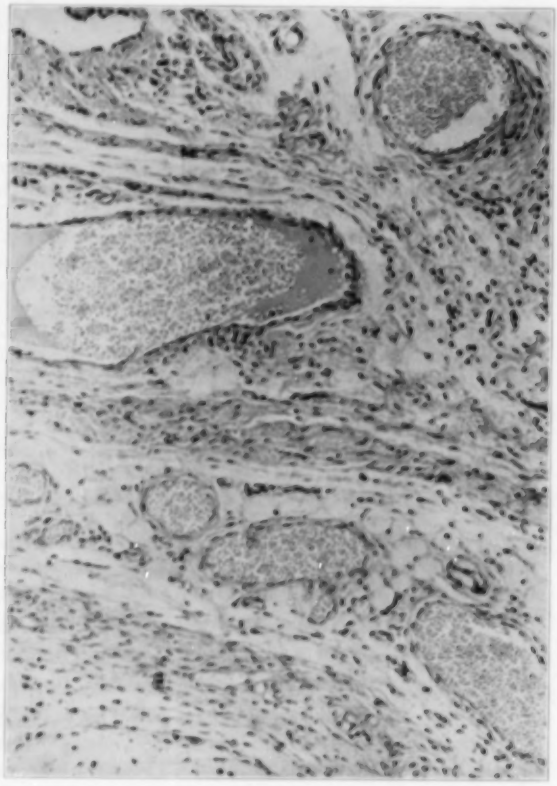

FIG. 3

Operation: On April 29, 1950, under general anaesthesia, the arm was elevated and an Esmarch bandage was placed from the tips of the fingers to the mid-portion of the arm. A blood-pressure cuff was applied above this and the Esmarch bandage was then removed. The field was prepared with soap and water, washed with ether, and painted with an antiseptic. Drapes were carefully arranged. An incision was made in the distal crease of the palm of the hand. This was deepened down through a small amount of adipose tissue. The tumor was encountered just above the palmar fascia. It was about two centimeters in diameter and rather purplish in color. The tumor extended through a small rent in the palmar fascia. The fascia was opened and the attachment was traced. It was found to be fixed to the flexor-tendon sheath of the third finger. The tumor mass was easily removed together with a portion of tendon sheath. Bleeding was arrested. The wound was closed in layers without drainage. The patient returned to the ward in good condition.

Motion was begun on the day of surgery. Sutures were removed on the sixth day and the wound healed *per primam*.

Pathological Examination: The specimen consisted of a small cystlike mass measuring 1.5 by one centimeters in diameter. It was bluish in color and covered with a well developed membrane. Upon section of the cystlike mass, a small amount of non-coagulated blood was discovered.

Microscopic Examination: The section showed the outer layer of the tissue to be covered by a well developed fibrous connective tissue. A few muscle cells were seen. The inner surface of this lining was composed of connective tissue with widely dilated blood vessels and marked hemosiderin deposits. The blood vessels were lined by an endothelial layer with a definite wall. There was connective tissue between these cells which showed some palisading.

The diagnosis was benign cavernous hemangioma of the tendon sheath.

The patient was lost to follow-up between July 1950 and May 4, 1953. On that date she appeared for re-examination. She presented no complaints referable to the right hand. All finger and hand motions were normal. The scar was soft and pliable and there was no evidence of recurrence of the tumor mass.

CASE 3.* M. H., a sixteen-year-old white male student, was examined in June 1950. He stated that for the past four months he had had a growth on the back of his right wrist. There was no history of trauma. A minimal amount of tenderness was noted. The patient had had no discoloration or any impeding of the motions of his right hand. The rest of the history was non-contributory.

Physical examination was essentially negative, except for the dorsum of the right wrist. About 2.5 centimeters proximal to the proximal crease on the dorsum of the right wrist a rounded, non-tender nodule

* The author is indebted to Dr. Frank J. Honsik for allowing him to present this case.

about 2.5 centimeters in diameter was noted. It seemed to move on flexion and extension of the index and second fingers and was not compressible. Blood pressure was 120 systolic, 80 diastolic in both arms. There was no change in sensory distribution over the dorsum of the wrist. Pronation, supination, elbow and shoulder motions were all present and normal. There were no sensory changes in the fingers or in the other areas of the hand. Radial and ulnar pulsations were normal. The tumor diminished in size on elevation of the hand, but did not disappear completely. Upon application of a rubber bandage the tumor almost completely disappeared. Application of a tourniquet caused the tumor to increase in size.

Laboratory findings were entirely within normal limits. The Kahn test was negative.

Operation: On July 7, 1950, the hand was prepared in the routine manner and general anaesthesia was employed. A transverse skin incision was made over the ganglion, subcutaneous bleeders were tied, the blood-pressure cuff on the right arm was inflated to a pressure of about 200 millimeters of mercury, and thereafter bloodless surgery was done. The cyst was carefully dissected out and down to the dorsal radio-ulnar ligament. It was found to extend beneath the tendon of the extensor pollicis longus and down under the tendons of the extensor digitorum communis. Each tendon sheath was opened and the ganglion was carefully dissected underneath and ablated *in toto*. No. 000 chromic catgut on an atraumatic needle was used to reapproximate some of the fascia and close up the dead space. The blood-pressure cuff was released and all bleeding points were tied. The field was completely dry. The skin was then closed with black silk. The patient left the operating room in good condition.

Motion began on the day of surgery. Sutures were removed on the sixth day and the wound healed *per primam*.

Pathological Examination: The specimen was a mass of tissue measuring 2 by 1.5 by 1 centimeters. The mass was cystic, firm in consistency, and yellow in color.

Microscopic Examination: The section showed considerable fibrosis with some myxomatous connective tissue and innumerable small capillaries, some of which contained blood. Very little inflammatory reaction was present. The connective tissue was hyalinized in some areas. There were many larger vessels and a few nerve trunks.

This type of growth is considered a small hemangiomatous growth, although it is not truly neoplastic. However, it has a tendency to recur and should be watched.

The diagnosis was hemangiomatous growth of the tendon sheath without evidence of malignant change.

At the present time the patient is serving with the United States Navy. When he was re-examined in January 1953, he presented no complaints. The finger, hand, and wrist motions were normal. The scar was soft and pliant. There was no evidence of recurrence of the tumor.

In regard to the point of origin of these tumors, the answer is not clear. King reported that these tumors arise from the synovial sheath rather than the fibrous sheath. In all of the cases here reported a generous portion of the tendon sheath was excised and in all probability the synovial sheath was excised also. In none of these cases was the point of origin determined, either because of the way the tumor was sectioned in the laboratory or because, since this tumor is rarely encountered, the correct diagnosis was not made until the microscopic sections were interpreted.

The follow-up on these three cases seems to substantiate the view that surgical excision is the treatment of choice [5,6,8,9]. Wide excision is rarely followed by recurrence.

REFERENCES

1. Boyd, William: Surgical Pathology. Ed. 4, p. 181. Philadelphia, W. B. Saunders, 1939.
2. Burman, M. S., and Milgram, J. E.: Haemangiomata of Tendon and Tendon Sheaths. Surg., Gynec., and Obstet., **50**: 397–408, 1930.
3. Buxton, St. J. D.: Tumours of Tendon and Tendon Sheath. British J. Surg., **10**: 469–474, 1923.
4. Geschickter, C. F., and Keasbey, L. E.: Tumors of Blood Vessels. Am. J. Cancer, **23**: 568–591, 1935.
5. Harkins, H. N.: Hemangioma of a Tendon or Tendon Sheath. Report of a Case with a Study of Twenty-four Cases from the Literature. Arch. Surg., **34**: 12–22, 1937.
6. Howard, L. D., Jr.: Tendon-Sheath Tumors. *In* Surgery of the Hand, by Sterling Bunnell, pp. 680–682. Philadelphia, J. B. Lippincott Co., 1944.
7. King, E. S. J.: Concerning the Pathology of Tumours of Tendon-Sheaths. British J. Surg., **18**: 594–617, 1931.
8. Lewis, Dean: Tumors of the Tendon Sheaths. Surg., Gynec., and Obstet., **59**: 344–349, 1934.
9. Mason, M. L.: Tumors of the Hand. Surg., Gynec., and Obstet., **64**: 129–148, 1937.
10. Morton, J. J.: Tumors of the Tendon Sheaths. Their Close Biological Relationship to Tumors of the Joints and Bursae. Surg., Gynec., and Obstet., **59**: 441–452, 1934.

11. Ragins, A. B., and Shively, F. L.: Further Observations on Benign Tumors of the Tendon Sheath. Ann. Surg., **109**: 632–640, 1939.
12. Webster, G. V., and Geschickter, C. F.: Benign Capillary Hemangioma of Digital Flexor Tendon Sheath. Ann. Surg., **122**: 444–448, 1945.

ROENTGENOGRAPHIC VISUALIZATION OF THE PATELLA

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TRANSLATED FROM THE GERMAN BY HENRY MILCH, M.D., NEW YORK, N. Y.

The standard roentgenographic views of the knee joint visualize the entire joint and are customarily made in postero-anterior and tibiofibular directions. Other oblique views[3,4] at different degrees of rotation of the extremity are made for visualization of particular areas of the knee. Of all of these only the lateral view reveals the isolated patella with its dorsal and ventral borders. The axial exposure, with the knee joint in maximal flexion, discloses only the anterior and posterior surfaces, but in a frontal projection and with visualization of the space between the patella and the femur.

The dorsoventral exposure is usually made when the need for roentgenographic representation of the entire patella arises. Since the part of the femur which overlies the patella is double the thickness of the patella, structural details can be determined only approximately, despite the proximity of the patella to the cassette. In this respect tomog-

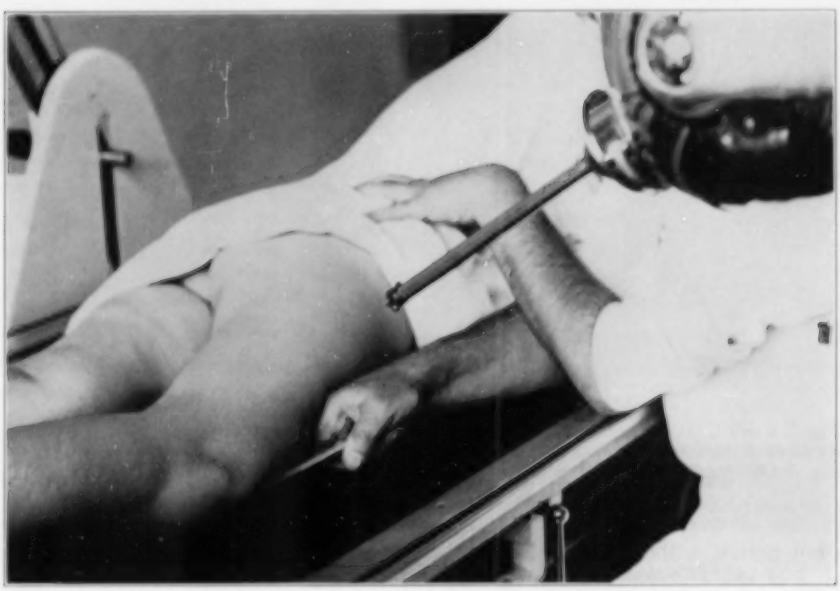

Fig. 1

With the extremity in moderate external rotation the patella is held in lateral subluxation with a wooden spatula, while the roentgen tube is held at a distance of seventy centimeters at a 40-degree angle to the patella.

* Director: Prof. Dr. G. Hohmann.

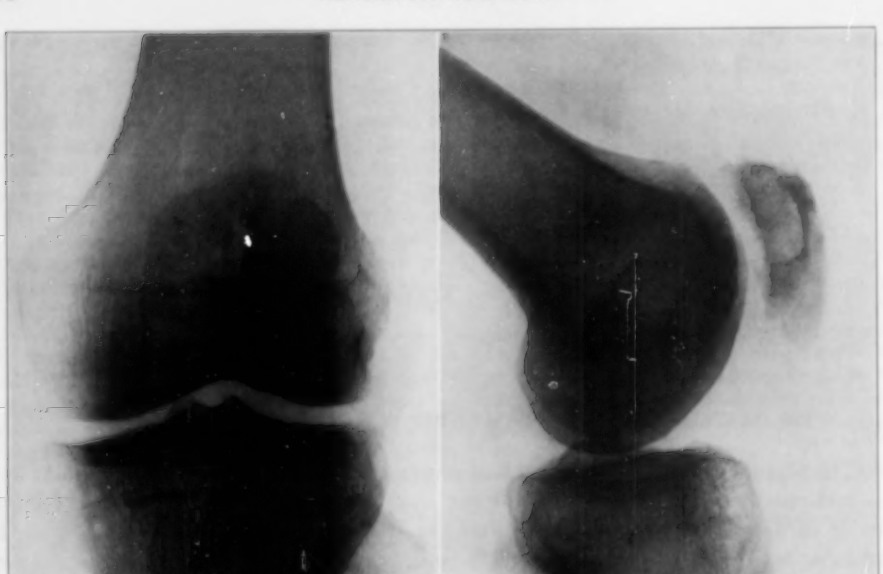

FIG. 2-A

FIG. 2-B

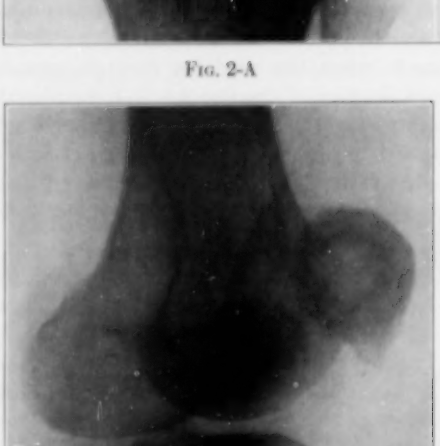

FIG. 2-C

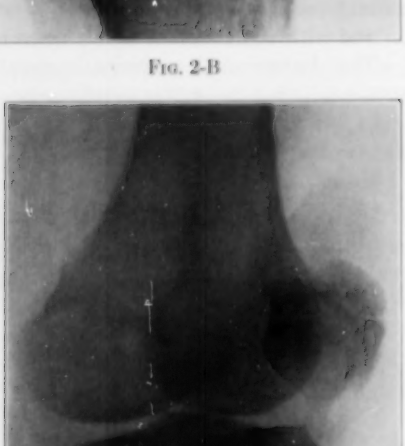

FIG. 3

Figs. 2-A to 2-C: Dorsoventral, lateral, and oblique dorsoventral roentgenograms of a knee joint showing a focus of destruction resulting from lymphogranulomatosis of the patella.
Fig. 3: Oblique dorsoventral roentgenogram of the knee joint in patella tripartita.

raphy also offers no aid. Since it affords only gross contrasts of bone cross sections, it does not permit a sharp focusing of the structures and may, indeed, result only in a blurring of the trabecular markings. When it is important to determine exactly any changes in the form and structure of the patella without overlay, the exposures used heretofore all fail. Representation of the patella alone is indicated not only in congenital anomalies such as patella partita, but also in degenerative changes, such as chondropathia patellae, and it is indicated especially, for both diagnostic and therapeutic purposes, in

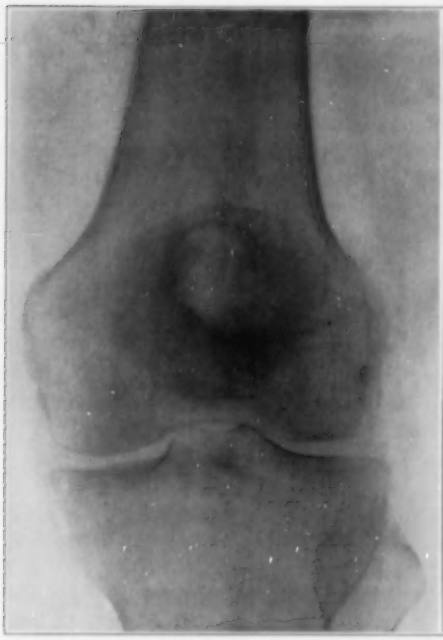

FIG. 4-A

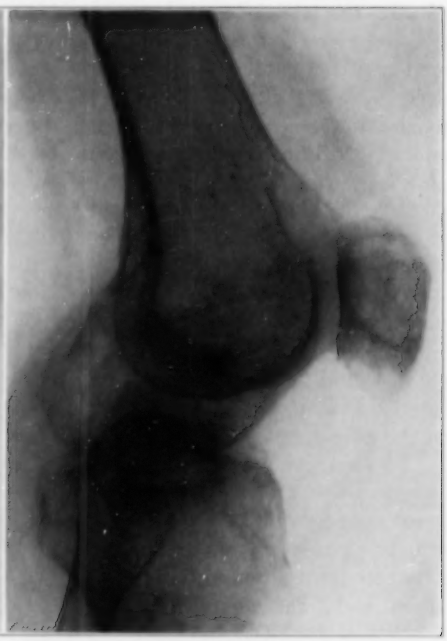

FIG. 4-B

FIG. 4-C

Figs. 4-A to 4-C: Dorsoventral, lateral, and oblique roentgenograms of a knee joint with a central fibrous dysplasia in the patella which was verified histologically.

destructive processes of an inflammatory or neoplastic nature.

To visualize the patella alone, Albers-Schönberg and Haenisch recommended the prone position, with the extremity internally rotated and the x-ray beam directed obliquely outward. Quite apart from the fact that in certain cases of congenital lateralization of the patella the femur overlies it, a large portion of the patella cannot be projected on the plate even when the patella is normally situated. The exact angle of internal rotation and the angle of incidence of the x-ray must be known if maximal projection of the patella is to be obtained. Any increase or decrease in either of these values alters the optimum relationship and thus yields a smaller patellar projection.

We therefore recommend a technique which, while based upon the method just described, permits a broad, isolated roentgenographic representation of the knee cap. The principle of the technique depends upon the fact that, with complete relaxation of the quadriceps, the patella can be displaced from its intercondylar position either medially or laterally to almost one half of its width. This displacement is not equal, since it depends upon the variations in flattening of the anterior surface of each condyle. Physio-

logically, the lateral femoral condyle is less developed and the patella can therefore be displaced more laterally. Before the roentgenographic exposure is made, the horizontal mobility of the patella should be tested and the side of the greatest excursion should be selected. Nevertheless, hardly half of the patella is thus exposed. To visualize more of the patella, the x-ray tube is placed on the subluxated side at a distance of seventy centimeters and at an angle of 40 degrees to the patella (Fig. 1). In order to visualize the greatest portion of the patella possible, the extremity is rotated 10 degrees laterally if the patella is dislocated laterally and it is rotated 10 degrees medially if the patella is dislocated medially. Greater external or internal rotation is to be avoided, since in the oblique view this creates a diminution of the image and only half the patella is visualized.

The patient lies in the prone position and the involved limb is fixed by sandbags around the ankle in the previously determined position of external or internal rotation. A cassette eighteen by twenty-four centimeters is placed beneath the knee, the femur is held fast, and the patella is forced outward or inward as much as possible. Care must be exercised that the patient is comfortable and the quadriceps is relaxed, since only thus can the patella be displaced from its gliding bed.

To hold the patella in this maximal lateral displacement and to avoid the use of shadow-casting aids, such as the finger of the assistant, a wooden spatula as wide as a tongue depressor and twice as long is used. In an emergency a small wooden ruler may be used. The x-ray tube is placed on the side of the patellar displacement, usually laterally, so that its central beam strikes the patella at an angle of 40 degrees. In this position the femoral and tibial condyles are projected obliquely. The patella is seen in a somewhat oblique postero-anterior projection and therefore appears slightly broader than in a pure anteroposterior view. It is seldom possible to displace the patella sufficiently so that it can be visualized in its entirety without femoral overlay. In most cases one third or one fourth of the patella is covered by a femoral condyle.

The rest of the patella can nevertheless be visualized in such a way that the contours and internal structure can be accurately scanned and all structural details can be clearly determined. Although the actual size and form of the patella are distorted because of the oblique projection, lateral displacement permits clear visualization of a large part of the patella without femoral overlay.

NOTE: The author wishes to thank Dr. Milch for his most painstaking translation of this article.

REFERENCES

1. ALBERS-SCHÖNBERG, H.: Die Röntgentechnik, S. 156–159. Hamburg, Gräfe und Sillem, 1903.
2. HAENISCH, H.: Diskussionsbemerkung. Verhandl. d. Deutschen Röntgen-Gesellsch., **3**: 54, 1907.
3. MACNEILL, CLYDE: Roentgen Technique. Springfield, Ill., Charles C. Thomas, 1946.
4. SANTE, LE ROY: Manual of Roentgenological Technique. Ann Arbor, J. W. Edwards, 1945.

MYELOGRAPHIC SIGN OF BRACHIAL PLEXUS AVULSION

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Avulsion of one or more roots of the brachial plexus is a complication which may follow severe traction injuries of the upper extremity. The classical syndrome described by both Duchenne and Erb occurs when the upper two roots are torn out of the spinal cord by a downward displacement of the shoulder. It consists in paralysis of the dorsal scapular and suprascapular nerves, the upper attachments of the long thoracic, the lateral anterior thoracic, the axillary, musculocutaneous, and a large portion of the fibers in the lateral head of the median nerves. Loss of sensation is found over the shoulder and outer aspect of the arm. The arm cannot be abducted, the elbow cannot be flexed, and the wrist cannot be supinated. In addition there is usually a "winging" of the scapula and the arm is internally rotated. On the other hand, when the arm is forcibly abducted in an upward direction and the shoulder girdle is elevated, the lower roots of the plexus may be avulsed. The Klumpke type of paralysis occurs when the first thoracic and eighth cervical nerve roots are torn, resulting in injury to the ulnar, medial head of the median, medial anterior thoracic, and lower spinal roots of the radial nerve. This results in severe paralysis of all

FIG. 1-A

FIG. 1-B

Figs. 1-A to 1-D: Case 1. Myelogram made seventeen years after injury to the left brachial plexus. (A left hemilaminectomy of the sixth and seventh cervical and the first thoracic vertebrae had been done four years after the injury.)

Fig. 1-A: A smooth-walled diverticulum continuous with the subarachnoid space extends through the left intervertebral foramen of the seventh cervical nerve.

Fig. 1-B: Subarachnoid pouches are now filled at both the seventh and eighth cervical intervertebral foramina.

FIG. 1-C

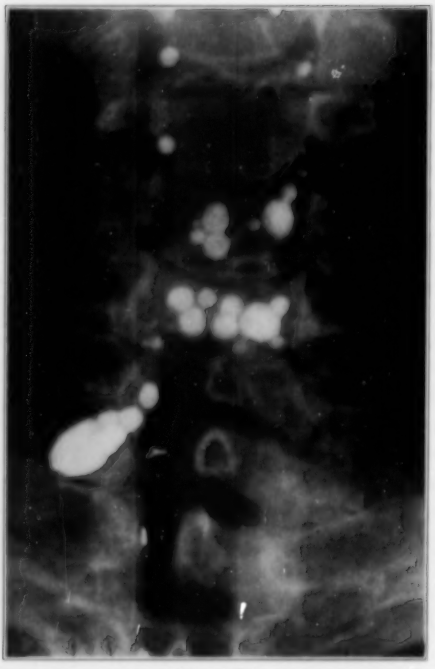

FIG. 1-D

Fig. 1-C: Both pouches are also shown filled in the oblique projection.
Fig. 1-D: After removal of the bulk of the pantopaque, residual medium persists within the eighth intervertebral foramen.

the intrinsic muscles of the hand, with weakening of the wrist and digital flexors, extensors, and abductors of the thumb, as well as of the triceps brachii. There is sensory loss down the inner aspect of the arm and hand, including the little finger and the medial half of the ring finger. Horner's syndrome and absence of perspiration in the corresponding side of the face are also found.

These neurological signs do not serve to discriminate definitely between avulsion or stretching of the spinal roots and more peripheral injuries to the lateral or medial cords of the plexus. However, paralysis of the long thoracic nerve in the upper type of lesion and the presence of sympathetic injury in the lower type indicate that the nerves are damaged before or soon after they leave the intervertebral foramina. It is also possible that other roots may be torn and the neurological signs may not be clear-cut. When the plexus roots are actually torn out of the spinal cord, no form of treatment can help, but if there is a stretch or tear in the cords of the plexus more laterally, proper immobilization or even neurosurgical intervention may be of value. Clear-cut roentgenographic evidence that one or more roots have been avulsed is therefore desirable.

That this evidence can be obtained by myelography was reported by Murphey, Hartung, and Kirklin in 1947, and again by Murphey in 1949. Murphey and his associates reported a case of a lower brachial plexus avulsion demonstrated by myelography. Laminectomy was not done, so that the lesion was never directly visualized.*

* Since this manuscript was submitted Jaeger and Whiteley (Jaeger, Rudolph, and Whiteley, W. H.: Avulsion of the Brachial Plexus. Report of Six Cases. J. Am. Med. Assn., **153:** 633–635, 1953) have reported the myelographic findings in three additional cases of brachial plexus avulsion and the appearance of the lesion on intradural exploration in five. They found the characteristic lateral diverticula filled with contrast medium in only one of the three. In the two others they failed to demonstrate the lesion by myelography and were forced to confirm the diagnosis by exploratory laminectomy. In these two failures the contrast medium was injected into the cistern and the amount used was not stated. We prefer the lumbar route, as

(*Continued on page 115*)

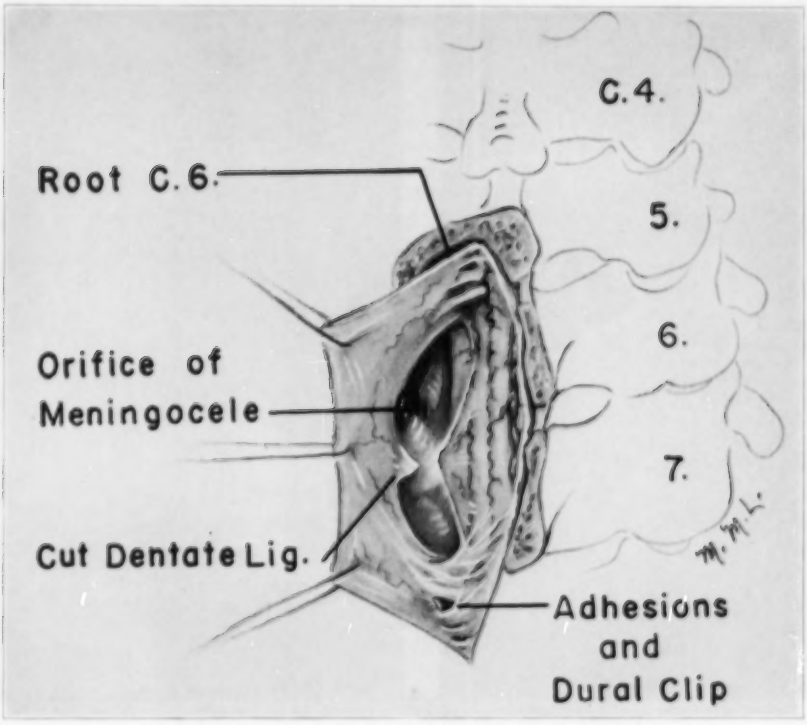

FIG. 1-E

Drawing made at operation, showing dura opened and dentate ligament divided. Note absence of rootlets of spinal nerves below the sixth cervical group.

The following three case histories and accompanying roentgenograms show that exact evidence of the presence and extent of spinal-root avulsion can be obtained by myelography. The operative findings in the first case, as illustrated in Figure 1-E, clearly show the reason for the peculiar outpocketings of the radiopaque solution through the intervertebral foramina.

Pantopaque [ethyl -10-(P-iodophenyl) undecylate] was the contrast medium employed in all three cases. The myelograms were done in the usual manner with the patient prone. Six to nine cubic centimeters of opaque medium was injected at a lumbar interspace and withdrawn through the same needle after fluoroscopy. In this position the intervertebral foramina are dependent; this favors filling of the traumatic diverticula. It may be difficult to empty these pockets completely of the pantopaque (Fig. 1-D). At one nerve-root level in Case 1 there was a delay in outlining of the traumatic pouch (Fig. 1-A). This was probably the result of obstructing adhesions found at the subsequent operation. In Case 3, where a complete brachial plexus avulsion had occurred, failure to demonstrate the ruptured upper roots was presumed to be due to obstructing disc protrusions (Fig. 3).

CASE 1. George M. (M.G.H. U-788190), fifty-three years old, was referred to us by Dr. Juan E. Fonseca of Tucson and Dr. John A. Eisenbeiss of Phoenix, Arizona. He was injured in 1935, when his left arm was caught in the belt of a farm engine. The arm was at first completely paralyzed and he suffered temporary impairment of bladder function and weakness of his left lower extremity. The latter complications cleared, but, with the exception of the triceps, he had never regained control of the muscles innervated by the three lower roots of the brachial plexus (the intrinsic muscles of the hand, the flexors and extensors of all

this permits the convenient use of a large volume of the contrast medium (six to nine cubic centimeters) which can be removed immediately after fluoroscopy. The appearance of the lesion in those of Jaeger and Whiteley's patients in whom laminectomy was done was similar to the findings in our first case.

FIG. 2

FIG. 3

Fig. 2: Case 2. Myelogram made seven months after injury showed the large diverticulum on the left extending through the fifth intervertebral foramen.

Fig. 3: Case 3. Myelogram made two months after injury. Traumatic meningoceles are present on the left at the emergence of the eighth cervical and first thoracic nerves. Filling of the upper avulsed plexus roots is presumably prevented by the large ruptured intervertebral discs at the fifth and sixth interspaces.

the fingers, and the abductors of the thumb) and he had not regained sensation over the corresponding dermatomes. In addition he had a clear-cut Horner's syndrome and did not sweat over that side of his face. Anaesthesia extended over the medial half of the arm and hand, together with all the fingers except the thumb (a pattern of motor and sensory loss somewhat more extensive than that characteristic of the Klumpke type of plexus injury). His chief complaint was continuous severe pain in the posterior portion of the axilla and the medial portions of the elbow, wrist, and hand, especially in the last three fingers. He had had a previous exploration of the brachial plexus by Dr. Rupert Raney in Los Angeles in 1939 and a resection of the first and second posterior thoracic roots at the Mayo Clinic. At this operation Dr. W. McK. Craig found that the lowest cervical root had been avulsed. Substantial temporary improvement had followed the last procedure, but recently the pain had increased and had become unbearable.

Anteroposterior, lateral, and oblique views of the cervical spine did not show any narrowing of the intervertebral-disc spaces or bony spurring indicative of disc protrusion or impingement by spurs. A pantopaque myelogram, made at the Massachusetts General Hospital in September 1952, revealed the striking diverticula in the region of emergence of the seventh and eighth cervical roots shown in Figures 1-A to 1-D. These outpouchings of the subarachnoid space were considered to be compatible with avulsion of the plexus roots.

In the hope of finding some remaining scarred sensory rootlets which were conducting painful impulses and could be cut, we reopened the previous incision and extended the laminectomy to include the sixth cervical vertebra. White's operation report read in part: "The dura was found to be heavily scarred below, but normal above. It was opened at C6 and the incision was then carried down through the scar at C7. One could then see the emerging rootlets of C6. These were in no way involved in adhesions. Then there was a gap where there were no rootlets coming out of the posterior longitudinal sulcus. This ran down for a good 3 cm. where there was a dural clip and then a mass of dense adhesions. The cord at this point was adherent to the lateral dura. Above, on freeing up the dentate ligament, one saw a large hole, 1 cm. in diameter, and then beyond that an outpocketing lined by smooth dura and arachnoid. This extended out some 2.5 cm. beyond the hole in the lateral wall of the dura exactly as shown by the pantopaque myelogram.

It was evident that the C7 root was torn away with its surrounding cuff of dura leaving a hole in the side of the main thecal sac. This space had a meningeal lining, as a result of cells proliferating from the dura-arachnoid, thereby resulting in a meningocele. There were no roots here that one could divide and the root above at C6 appeared quite normal. I did not see any purpose in cutting that root and it would have left his lower arm totally insensitive and without any position sense. Below at C8 there were no visible rootlets. I am sure they are all atrophied and damage would have occurred pretty surely in the pyramidal tract had I tried to free up these adhesions. Furthermore they would have re-formed. I was therefore faced with the necessity of closing without having accomplished any definite step to relieve his pain."

Figure 1-E, the drawing made at operation, shows the opening in the side of the dura from which the seventh cervical root was torn. The lesion below, which must have been identical, was not visualized.

With this impressive demonstration of the value of myelography, we reviewed our cases of avulsion of the brachial plexus and found two similar examples. The first had had an injury to the upper plexus.

CASE 2. Lee R. (M.G.H. U-780577), a seventeen-year-old boy, was injured in an automobile accident in July 1952. He suffered concussion, closed fractures of both femora, and comminuted compound fractures of the left tibia and fibula. After emergency treatment at another hospital, he was transferred to the Massachusetts General Hospital, where he regained consciousness. It became evident that he had also suffered severe injury to the left brachial plexus. After treatment of the fractures, the plexus injury was evaluated by Dr. Watkins in the Department of Physical Medicine and Rehabilitation. A typical Duchenne-Erb avulsion of the upper plexus root was found to be present. There was paralysis of the supraspinatus and infraspinatus, serratus magnus and rhomboids, teres major, subscapularis, brachioradialis, biceps, and deltoid.

A cervical myelogram, made on January 27, 1953, after injection of 5.5 cubic centimeters of pantopaque, revealed the lateral defect in the dura-arachnoid, shown in Figure 2, at the level of the fifth cervical interspace.

With preservation of power in the triceps, as well as in most of the muscles of the forearm and hand, and with improvement as a result of physical therapy, the boy was discharged six weeks after his injury.

CASE 3. Paul S. (M.G.H. U-701400), forty-four years old, the first patient in whom the characteristic myelographic defect was observed, was hit by a car on the road. His hand was caught in the door handle and he was dragged for a considerable distance. He stated that immediately after the injury he had a headache and was not able to move his lower extremities or his left arm. However, the weakness in the lower limbs disappeared, and on admission two months later his complaint was excruciating pain in his left paralyzed arm. Since his accident, he had been unable to move this arm, and it felt dead despite intensely disagreeable paraesthesiae.

Examination showed complete motor paralysis of the entire brachial plexus. Electrical examination revealed reaction of degeneration involving all the muscles in the arm, and electromyography confirmed the completeness of the denervation. Sensory paralysis was equally complete.

A cervical myelogram was made on June 15, 1950, with an injection of 5.5 cubic centimeters of pantopaque at the third lumbar interspace. Unfortunately the oil broke up into multiple globules on reaching the cervical canal, but large defects in the oil column were present and persisted at the level of the fifth and sixth left interspaces. The two nerve sleeves below this level on the left were considerably enlarged (Fig. 3).

On review of these films with our recently added knowledge, it was evident that these defects resulted from avulsion of the eighth cervical and first thoracic roots. The large defects above, at the level of the fifth and sixth interspaces, probably resulted from protruded discs which may well have prevented filling of the avulsed upper roots.

Dr. William H. Sweet, who was in charge of the patient, felt that the arm would remain totally useless and that the best procedure would be to relieve the patient of his pain.

Accordingly on June 27, 1950, he carried out a spinothalamic tractotomy in the medulla at the level of the obex. This produced analgesia to the second cervical segment and gave effective relief of pain; recovery was uneventful and the arm was subsequently amputated. Eight months later the patient was in good condition and free of his previous distressing pain.

DISCUSSION

These striking myelographic findings can be explained by the fact that, in addition to the avulsion of the spinal rootlets, the arachnoid and dura were torn off as well. The

arachnoid accompanies the root for a variable distance through the intervertebral foramen. A funnel of dura also envelops each sensory-motor root as it enters the intervertebral foramen and then becomes the epineurium of the spinal nerve. When this cuff is torn out of the side of the dural sheath which surrounds the spinal cord, cerebrospinal fluid pours out of the hole in the arachnoid to fill the cavity left by the retracted distal stump of the nerve. This space may enlarge still further in the course of the next few weeks because of shrinkage of the severed nerve by wallerian degeneration. There must then be a gradual proliferation and fusion of dura and epineurium lined with re-formed arachnoid, so that a traumatic meningocele is produced. This is clearly demonstrated by the myelograms and the opening in the side of the dura which presented such a striking appearance at the time of exploration in Case 1. In our experience these large prolongations of the subarachnoid space into and through the intervertebral foramina have been associated only with avulsion of the brachial plexus. The evidence presented suggests that this characteristic picture will be found in other subjects if radiopaque oil is injected intrathecally and the body is tilted under fluoroscopic control so that the oil enters the meningeal outpocketings created by avulsion of spinal roots and their surrounding meninges.

SUMMARY

When roots of the brachial plexus are avulsed, a cuff of dura-arachnoid is torn out of the spinal theca. With retraction and shrinkage of the severed stump, a cavity is created which fills with spinal fluid. It is gradually enclosed by re-formation of the ruptured arachnoid and dura, and a traumatic meningocele is formed. This can be readily filled with radiopaque media, and the presence and extent of root avulsion can be demonstrated by myelography.

REFERENCES

1. Murphey, Francis: Brachial Plexus. *In* Campbell's Operative Orthopedics, edited by J. S. Speed and Hugh Smith. Vol. I, pp. 755–762. St. Louis, The C. V. Mosby Co., 1949.
2. Murphey, Francis; Hartung, Walter; and Kirklin, J. W.: Myelographic Demonstration of Avulsing Injury of the Brachial Plexus. Am. J. Roentgenol., **58**: 102–105, 1947.

DISCUSSION

Occult Derangements of the Medial Meniscus

(*Continued from page 93*)

ated as being most common to these patients. These clinical features are accounted for and explained by the derangements of the medial meniscus which were found at the time of surgical exploration.

In our initial experience we found this clinical entity difficult to evaluate. Critical study of the position, shape, lateral mobility, and general mechanics of the medial meniscus, as demonstrated at the time of exploration, gave us an increasing appreciation of the underlying mechanism causing the persistent symptoms and findings in the region of the tibial collateral ligament. Unless care is taken to observe and preserve these relationships at the time of cartilage exploration, the meniscectomy technique used by most of us (mobilization of the anterior third of the cartilage preparatory to total cartilage removal) will mutilate and destroy both the cartilage and its anatomical relationships by the time one reaches the area of the tibial collateral ligament to observe the mechanism present there. In recent years, it has been our operative policy to make our anteromedial utility incision a little longer and a little more posterior, close to or just in front of the anterior margin of the tibial collateral ligament. This allows us to observe the middle third of the cartilage *in situ*, and to demonstrate its lateral mobility and degree of displacement, as well as its relationship to the tibial collateral ligament, during passive manipulation of the knee joint. Lesser degrees of this type of derangement can only be demonstrated in this manner and cannot be demonstrated after the anterior moorings of the cartilage have been disturbed.

Dr. O'Donoghue's re-emphasis of the fact that these are selected patients is a point well taken. The last impression that we would want to leave with you is that we routinely arthrotomized all patients who presented this syndrome. I can safely say that the majority of our patients presenting this syndrome have not

(*Continued on page 132*)

THE SURGICAL TREATMENT OF SPASMODIC TORTICOLLIS *

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At the present time, many forms of therapy including psychiatric, medical, orthopaedic, osteopathic, and neurosurgical have been tried to relieve spasmodic torticollis, with results that leave much to be desired. From a review of the reports in the literature, it would appear that neurosurgery has offered the greatest hope of relief in this distressing disorder. Many feel that strong psychiatric factors are the primary forces at play; yet few cases have been permanently relieved by psychiatric therapy. It is admitted that about one half of these unfortunates have psychological disturbances, but they are secondary rather than primary. Of course, there are those patients with bizarre hysterical attitudes of the head and neck which respond to psychotherapy. These, however, should not be considered as cases of true spasmodic torticollis.

In this report are included only those cases characterized by painful, persistent or intermittent, muscle contractions producing a typical torticollis attitude. Foerster [5,6] explained the abnormally involuntary movements as resulting from an intermittent flow of thalamic impulses by way of the pallidum, following the occurrence of lesions of the corpus striatum. At the present time, studies are under way to determine the role of pallidofugal impulses in spasmodic torticollis, with the aid of the stereotaxic method (stereo-encephalotomy) developed by Spiegel and Wycis.

Krisch and Spiegel produced mild alterations in tonus by placing lesions in the motor area of the frontal lobe (Brodmann's area 4), subcortical white matter, and caudate nucleus. Bulbocapnine had been administered, and as its effects appeared, latent changes in tonus became exaggerated so that the experimental animals showed typical torticollis-like deformities.

At the present time, surgical therapy, although aimed at the peripheral destruction of the involuntary movements, is the best to be offered. The earliest surgical attempts were directed to sectioning muscular attachments. This was introduced by Isaac Minnius in 1641, and later advocated by Kocher, Mikulicz, and de Quervain. Myotomy was abandoned after nerve section proved more effective and permanent. Sectioning of the spinal accessory nerve in the neck was first performed by Bujalski in 1834. In 1891 Keen tried bilateral section of the posterior division of the first three cervical-nerve roots, a procedure later modified by Finney and Hughson, who added bilateral sectioning of the spinal accessory nerve in the neck. The first intradural approach was devised by Taylor in 1915. He sectioned the posterior divisions of the first four cervical nerves. The intradural procedure of bilateral sectioning of the anterior and posterior division of the first three cervical and the spinal accessory nerves was introduced by Foerster in 1920 and was further developed by Dandy in 1930. This is now considered to be the most effective therapy. As in other conditions in which surgery is advocated, many feel that the surgical procedure should be designed to meet the needs of each individual patient. This was particularly emphasized by Dowman in the treatment of spasmodic torticollis. Consequently, many patients have had a variety of procedures performed upon them and many without sufficient or permanent relief. It is agreed that each case should be studied with regard to the muscle groups involved, particularly since in most cases there is mild or severe bilateral involvement and the muscles of one side may not be so extensively involved as those of the opposite side. The electromyographic studies of individual muscles as reported by Herz and Hoefer may

* Read at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Chicago, Illinois, January 29, 1953.

be helpful to the neurosurgeon in deciding which operative procedure is best suited to a particular patient. Most patients with severe bilateral involvement, however, will require the most radical procedure (the Foerster-Dandy operation) as advocated by Putnam and his associates.

In the present series of nine cases, all of the patients were severely incapacitated by persistent intermittent or continuous involuntary muscle contraction of both sides. In studying the muscle groups involved and their innervation, it was obvious that a complete denervation of the long muscles of the neck was impossible. The splenius capitis and cervicis, longissimus capitis and cervicis, semispinalis capitis and cervicis, iliocostalis cervicis, interspinalis cervicis, spinalis cervicis, and multifidus cervicis are supplied by spinal-cord

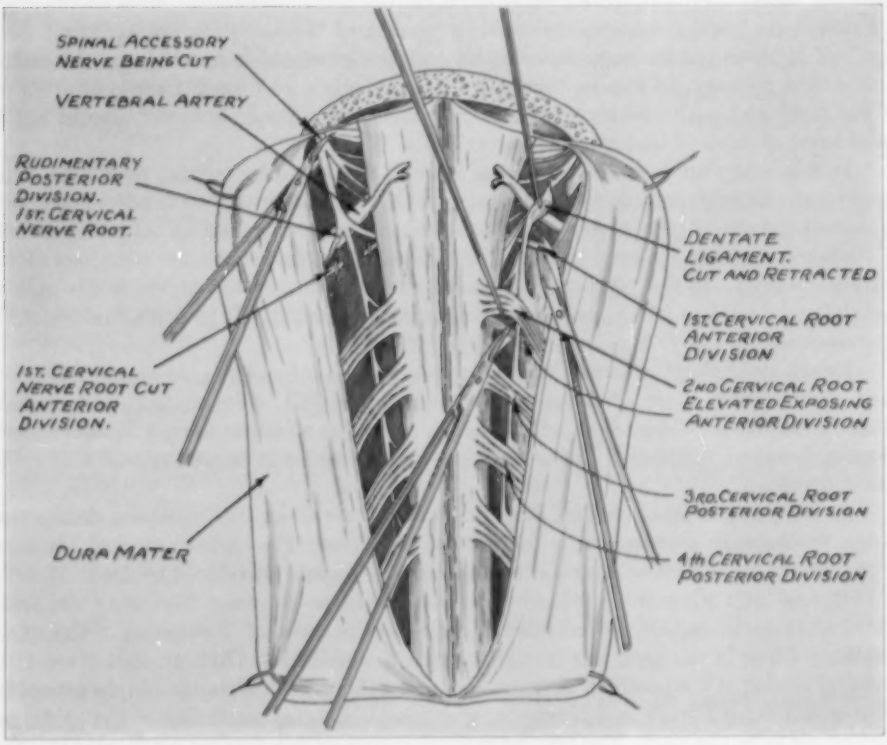
SPINAL ACCESSORY NERVE BEING CUT
VERTEBRAL ARTERY
RUDIMENTARY POSTERIOR DIVISION. 1ST. CERVICAL NERVE ROOT.
1ST. CERVICAL NERVE ROOT CUT ANTERIOR DIVISION.
DURA MATER
DENTATE LIGAMENT. CUT AND RETRACTED
1ST. CERVICAL ROOT ANTERIOR DIVISION
2ND CERVICAL ROOT ELEVATED EXPOSING ANTERIOR DIVISION
3RD. CERVICAL ROOT POSTERIOR DIVISION
4th CERVICAL ROOT POSTERIOR DIVISION

FIG. 1

Exposure of spinal cord and medulla showing intradural section of the spinal accessory nerves, anterior cervical-nerve roots, and section of the dentate ligament to facilitate exposure of the first anterior cervical-nerve root.

segments from the first cervical to the first thoracic inclusive. It is apparent, therefore, that the sectioning of both spinal accessory nerves and the first three anterior cervical roots would be insufficient to abolish completely all the muscular movements of the neck, and this is particularly true in those cases which show extensive bilateral involvement of the muscles named above. In the past, operators were hesitant to section more anterior roots, since the nerve supply to the diaphragm would be interrupted. This very fact led other operators to attack the fourth, fifth, and sixth cervical-nerve roots extraspinally. The phrenic nerve supplying the diaphragm receives its supply from the third, fourth, and fifth cervical segments and, according to Morris's *Human Anatomy*, chiefly from the fourth cervical root. It usually receives a small communicating branch from the sympathetic nerve and rarely a branch from the vagus nerve.

The operative procedure adopted in these cases was, therefore, the most radical. In one of the cases the fourth anterior cervical-nerve root was sectioned bilaterally, while in three other cases it was sectioned unilaterally. Diaphragmatic paralysis apparently did not develop, and fluoroscopic examination of the diaphragm after operation showed the leaves to move in normal phase with respiration. A brief summary of each case follows.

CASE REPORTS

CASE 1. Mrs. M. F., a housewife, thirty-five years old, was admitted to Temple University Hospital on March 8, 1945. Four years prior to admission, she had noted a turning of her head to the right while talking. Progression of her illness caused her to seek the services of an osteopathic physician. Osteopathic manipulations failed to relieve her. In 1943 a cast was applied to the neck for a period of sixteen months, and then a chin-occiput support was used. Her condition became progressively worse. The left sternocleidomastoid muscle and the right trapezius showed the most predominant spasm. Several psychiatric interviews were obtained and an analysis under sodium amytal was tried. Various drugs including benzedrine and tincture of stramonium were tried without relief. On March 14, 1945, both spinal accessory nerves and the anterior roots of the first, second, and third cervical nerves were sectioned intradurally. The patient's recovery was quite dramatic and she remained free of her torsion spasms for a period of six years. At that time she died of metastatic carcinoma, the primary site being in the breast (Figs. 2-A and 2-B).

In this case there was an attempt made to section the first, second, and third anterior cervical roots without disturbing the posterior divisions. It was discovered that division of the first anterior root could be facilitated by dividing the uppermost dentate ligament and rotating the medulla, thus bringing the first root into a better position for sectioning.

CASE 2. Mr. P. R., a bricklayer, forty-one years old, was admitted to Temple University Hospital on January 9, 1946. In October of 1943, his neck had started to pull toward the right side. The spasms became persistent and were associated with pain in the region of the right scapula. Osteopathic treatments failed to relieve him. Alcohol taken orally would alleviate the painful spasms temporarily, but later he would have greater discomfort. In 1944, another neurosurgeon sectioned the tendon of the left sternocleidomastoid muscle, without lasting relief. On January 18, 1946, both spinal accessory nerves and the anterior roots of the first, second, and third cervical nerves were sectioned bilaterally and intradurally. His neck has maintained a normal posture since that time. Fluoroscopic examination of the diaphragm and swallowing act showed normal functioning before and after operation.

FIG. 2-A
Before operation.

FIG. 2-B
After operation.

It is of interest to note that many of these patients were under the care of an osteopathic physician at some time during the course of their illnesses. Attention was called to this factor in the history by Putnam and his associates.

Case 3. Mrs. F. S., a housewife, thirty-six years old, was admitted to Temple University Hospital on November 24, 1947. Two years prior to admission, she had noticed a jerking of her head toward the left side. The jerking movements would cause the head to fall to the right side. On examination, the head was tilted backward and to the right and the right sternocleidomastoid, trapezius, splenius capitis, longus colli, and longissimus cervicis muscles were found to have the greatest spasm. Orthopaedic braces and appliances were tried without relief; and psychotherapy administered over a long period did not appear to influence the course of the illness. On November 26, 1947, both of the spinal accessory nerves were sectioned intradurally and on the left side the first three anterior cervical roots were divided, while on the right side the anterior roots of the first, second, third, and fourth cervical nerves were divided. The diaphragm was examined five years later and found to move normally in the respiratory phases. The patient has remained well and free of spasms for five years (Figs. 3-A and 3-B).

This was the first time that the fourth anterior cervical root was sectioned on one side. In view of the extensive involvement of the muscles on the right side of the neck, it was felt that this procedure was justified.

Case 4. Mrs. J. C., a housewife, thirty-seven years old, was admitted to Temple University Hospital on January 2, 1949. One month after a trivial trauma to the back of the neck and shoulders in May 1948, she noted a pulling of her head toward the right shoulder. She was unable to control the jerking movements, so that the head assumed a position of extreme lateral flexion toward the right shoulder. Although the posture of the head was similar to that seen in hysterical attitudes, it was not relieved by psychotherapy administered over a prolonged period of time. She was referred to us by an orthopaedic surgeon who had tried various orthopaedic measures without relief. On January 5, 1949, both spinal accessory nerves and the anterior roots of the first, second, third, and fourth cervical nerves were sectioned bilaterally. Examination of the diaphragm fluoroscopically before and after operation did not reveal any abnormalities. She has remained free of spasms for a period of over four years.

This was the first case in which the first four anterior cervical roots were sectioned on both sides without deleterious results. Because of the extensive involvement of the musculature on both sides, it was felt that this procedure was justified.

Case 5. H. K., a mail carrier, forty-eight years old, was first admitted to Temple University Hospital on July 7, 1942. During the previous August he had noticed a stiffness of the neck which was replaced by jerking of the head toward the left side. The chin would turn toward the left, and the back of the head toward the right shoulder. The muscles of the right shoulder girdle were in spasm, so that his shoulder was elevated on that side. Extraction of all the teeth failed to relieve him; head-halter traction and a Thomas collar were tried without benefit. During the attack of spasm, the chin would turn toward the left shoulder and would curve upward. The occiput turned toward the right shoulder and tilted downward. The powerful contractions of the right sternocleidomastoid and trapezius muscles were readily visible as well as palpable. The spasms were associated with severe pain at the base of the occiput. Dr. Temple Fay sectioned both of the spinal accessory nerves and the posterior roots of the second, third, and fourth cervical nerves bilaterally and intradurally. The patient was discharged partly relieved. He was re-admitted on March 7, 1949, because six months prior to this time severe painful contractions of both platysmal muscles had developed. Section of the facial nerve at the angle of the jaw on both sides resulted in instant relief. He had to be re-admitted on June 6, 1949, because of a recurrence of his former torticollis. In the interval between 1942 and 1949, he had never been completely free of spasms in the neck which twisted his chin to the left. On June 8, 1949, the old laminectomy wound was re-opened. The anterior roots of the first, second, and third cervical nerves were sectioned intradurally and bilaterally. A small remaining filament of the spinal accessory nerve on the right side was also sectioned. He has remained free of spasms since that time.

It is noteworthy that sectioning of the posterior roots alone is insufficient to abolish the painful muscle contractions in these cases. Sectioning of the branch of the facial nerve which supplies the platysma muscle is made feasible by exposure of the nerve at the angle of the jaw.

Case 6. Mr. H. H., a truck driver, fifty-four years old, was admitted to Temple University Hospital on March 7, 1950. His symptoms began six months prior to admission with violent, painful, uncontrollable movements of the head toward the right side. This was associated with elevation of the right shoulder. He was able to correct the posture for about thirty to forty seconds at a time. The contractions would cease

FIG. 3-A
Before operation.

FIG. 3-B
After operation.

with sleep. He was given psychiatric therapy, but he showed no improvement. On March 15, 1950, both spinal accessory nerves and the anterior roots of the first, second, and third cervical nerves were sectioned intradurally and bilaterally. In addition, the fourth anterior cervical root was sectioned on the right side. Fluoroscopy of the diaphragm before and after the procedure revealed no disturbances of movement. The patient made a gradual but progressive recovery and is now free of contractions. He is employed full time.

In this case it is believed that psychogenic factors were minimal, if present at all. Perhaps one should wait longer before operating upon such patients; however, in this instance, the pain associated with muscle contractions was so severe that operation seemed justified at the time.

CASE 7. Mrs. D. S., a housewife, twenty-seven years old, was admitted to Temple University Hospital on May 1, 1952. Her symptoms began in January 1951 with twisting and turning of the head to the right side. The spasms were attended with a shooting pain behind the left ear. Her symptoms were aggravated by emotional upsets. She had been under the care of an osteopathic physician who later referred her to a psychiatrist. Psychiatric therapy apparently did not influence the course of the disease. On May 12, 1952, both spinal accessory nerves and the anterior roots of the first, second, and third cervical nerves were sectioned intradurally on both sides, and the fourth anterior cervical root was sectioned on the right side. Fluoroscopic examination of the swallowing act, as well as of the diaphragm, was made before and after operation. No abnormalities were demonstrable. She has made a good recovery.

CASE 8. Mr. L. B., an internal revenue agent, fifty-one years old, was admitted to Temple University Hospital on July 8, 1952. Approximately a year and a half prior to admission, the patient became aware of a slow, progressive stiffening of the neck and turning of the head to the right. The head would maintain a fixed attitude with the chin turned toward the left shoulder. With the head fixed in this position, it was difficult for him to maintain normal equilibrium while walking. He received a series of injections from his local physician and had osteopathic manipulations for a period of one month. Head-halter traction was tried and he wore a brace for a period of three months. A pantopaque cervical myelogram was found to be normal. On fluoroscopic examination the leaves of the diaphragm appeared to be of normal contour and showed normal excursion. On July 23, 1951, both spinal accessory nerves and the anterior roots of the first, second, and third cervical segments were sectioned intradurally and bilaterally. The fourth anterior cervical root was also sectioned on the left side. Postoperative examination of the diaphragm showed it to be normal. After operation the patient's head tilted toward the left, but the position was much improved.

The incomplete recovery in this instance may be attributed to incomplete section of the spinal accessory nerve on the right side. The spinal accessory nerve was sectioned

in the neck on that side at a later date, and this procedure resulted in no further improvement.

CASE 9. Mr. J. M., an office clerk, forty-four years old, was admitted to Temple University Hospital on November 12, 1952. Two years prior to admission he had experienced difficulty in keeping his head in a normal position. The head would turn toward the left shoulder. The muscle contractions were intermittent and were not associated with pain. He was treated by an osteopathic physician without relief. Orthopaedic appliances were also tried without benefit. A pantopaque myelogram was made prior to surgery, but no abnormalities were found. Fluroscopic examination of the diaphragm showed it to be normal. On November 17, 1952, both spinal accessory nerves and the anterior roots of the first, second, and third cervical nerves were sectioned bilaterally and intradurally. Immediately after the operation, the head assumed a normal position and has maintained it to the present time.

The results in this case were short of dramatic; but the time interval since operation has been too short to allow a final opinion.

DISCUSSION

It was fortunate that one of us (H. T. W.) was stimulated by Dr. John Royal Moore to treat these patients surgically, in view of the previous unpredictable and unsatisfactory results. Most of these patients had been previously studied by Dr. Moore and were referred for neurosurgical therapy. In addition, these cases were also studied by him from the standpoint of muscle deficiencies after denervation.

Orthopaedic Observations

Spasmodic torticollis is an involuntary hyperkinesis manifesting itself by mobile tonic or clonic spasms in the neck muscles and producing a more or less stereotyped deviation of the head and neck to an abnormal position. The head is turned to the right or left, laterally flexed to the right or left, and extended or flexed. The position is maintained intermittently or continuously by spasmodic contractions of various neck muscles including the trapezius, the sternocleidomastoid, and the splenius. One incontrovertible fact seems to be that the spasm is never restricted to one muscle or one group of muscles and is never unilateral. Selective denervations, myotomies, myectomies, and tenotomies have been employed, usually with unfavorable results. Muscles have been found to be normal except for hyperkinesis. No other pertinent findings have been noted and other causes of torticollis have been carefully eliminated. Conservative therapy, including psychotherapy, mechanotherapy, and physical therapy, gave only temporary relief. The patients are extremely depressed, and are often inclined to suicide. They complain of the humiliating deformity, as well as of the fatigue and pain associated with the constant jerking movements and the effort to combat them. The neurosurgical approach seems justified in view of the evidence that indicates localization of the lesion in the neostriatum and the failure of other methods in relieving this condition.

The effect of denervation is dramatic. The mental depression, the deformity, and the incoordinated jerking movements are usually absent. The patient has a pleasantly surprised look. The head is carried upright and perhaps a little forward, and all movements are retained, being most effective when gravity is eliminated in the erect positions. Flexion and extension are weakly executed in the prone and supine positions. There may be slight difficulty in swallowing, and the shoulders are at a lower level. The patient's only complaint is of neck weakness and this information is derived only by direct questioning.

How are function and stability maintained in view of the extensive paralysis? The patient literally learns to balance his head upon his cervical spine and in a sense becomes a head juggler. The following factors play a part in the establishment of function, stability, and balance:

1. The normal cerebellar mechanism;
2. The inherent stability of the cervical spine and ligaments;

3. The development of an anterior occipital cervical curve which compensates the newly acquired cervical kyphosis. The two curves afford a type of locking or stabilizing mechanism;

4. Segmental innervation affords residual although weak power to the long paired cervical and caput muscles, along with other paraspinal muscles, including the scaleni, the trapezius, and occasionally the levator scapulae, the omohyoid, and other muscles, the origin of which may occur below the level of the fourth cervical segment;

5. Muscle substitution also occurs, as in the case of the suprahyoid muscles and the platysma, which assist in forward flexion of the head on the spine.

The patient improves slowly with time, and this impression is supported by the reports of Finney and others on a larger series of cases with even longer follow-up. The spontaneous stability and the reasonably good function permit the patient to return to his usual occupation. Bracing has not been necessary. Occipitospinal fusion has been considered but, in view of the technical difficulties and the experiences of Young and others, it has not been used.

If the problem is purely a psychogenic one, then psychiatry with all its tools should do much to restore these unfortunate individuals to normality. It is true that psychogenic factors color the true nature of this disorder, but we feel that these factors are secondary and are not primary.

Although this operation is essentially destructive, we believe that the results in this group justify the procedure. It is our sincere hope that some less destructive form of therapy may soon supplant this type of approach. Possibly a way may be found to interrupt the pathways of these abnormal impulses more centrally. Because of the hazards involved and the muscle deficiencies it produces, the operation used in these cases is not the answer to the problem, the etiology of which remains obscure.

REFERENCES

1. Bujalski, I. W.: Unterbindung beider Nervi accessorii Willisii J. f. Chir. u. Augenheilk. (v. Graefe u. v. Walther), **23:** 335–336, 1835.
2. Dandy, W. E.: An Operation for the Treatment of Spasmodic Torticollis. Arch. Surg., **20:** 1021–1032, 1930.
3. Dowman, C. E.: Spasmodic Torticollis. Surg., Gynec., and Obstet., **53:** 836–840, 1931.
4. Finney, J. M. T., and Hughson, Walter: Spasmodic Torticollis. Ann. Surg., **81:** 225–269, 1925.
5. Foerster, O., *In* discussion on Torticollis Spasticus by L. Mann. Zentralbl. f. Chir., **47:** 1106–1107, 1920.
6. Foerster, Otfrid: On the Indications and Results of the Excision of Posterior Spinal Roots in Men. Surg., Gynec., and Obstet., **16:** 463–475, 1913.
7. Herz, Ernst, and Hoefer, P.F.A.: Spasmodic Torticollis: I. Physiologic Analysis of Involuntary Activity. Arch. Neurol. and Psychiat., **61:** 129–136, 1949.
8. Keen, W. W.: New Operation for Spasmodic Wry Neck, Namely, Division or Exsection of the Nerves Supplying the Posterior Rotator Muscles of the Head. Ann. Surg., **13:** 44–47, 1891.
9. Kocher, Th.: Vereinsberichte. Corresp.-Bl. f. Schweizer Aertze, Basel, **42:** 419–420, 1912.
10. Krisch, H., und Spiegel, E. A.: Sichtbarmachung latenter, experimentell hervorgerufener Tonusstörungen mit Bulbocapnin. Zeitschr. f.d. Ges. Neurol. u. Psychiat., **122:** 535–544, 1929.
11. Mikulicz, J.: Über die Exstirpation des Kopfnickers beim muskulären Schiefhals nebst Bemerkungen zur Pathologie dieses Leidens. Centralbl. f. Chir., Leipzig, **22:** 1–9, 1895.
12. Putnam, T. J.; Herz, Ernst; and Glaser, G. H.: Spasmodic Torticollis: III. Surgical Treatment. Arch. Neurol. and Psychiat., **61:** 240–247, 1949.
13. de Quervain, F.: Le traitement chirurgical du torticolis spasmodique d'après la méthode de Kocher. Semaine Med., **16:** 405–409, 1896.
14. Spiegel, E. A., and Wycis, H. T.: Stereoencephalotomy. New York, Grune and Stratton, 1952.
15. Taylor, A. S.: Operation for Relief of Spasmodic Torticollis. *In* Operative Therapeusis by A. B. Johnson, pp. 533–535. New York, D. Appleton and Company, 1915.

DISCUSSION

Dr. Loyal Davis, Chicago, Illinois: Dr. Wycis and Dr. Moore have given a fine pictorial demonstration of the operation for relief of spasmodic torticollis, and, as time permitted them, have said something about the development of the present procedure in treating these patients. It is a very interesting history to

us because, as was indicated, it began with a sectioning of muscles and fixation in casts and braces. At the same time there was a widespread feeling, particularly among neurologists, before psychiatrists had become so plentiful, that this was a habit spasm due mainly to some underlying psychiatric factor. This belief was due, I think, mainly to the fact that many of these patients, at least in the beginning, can stop their spasm by a restraining gesture. Gradually that feeling disappeared; and now the question is whether or not spasmodic torticollis is another example of one of the dystoniae which arise from diseases of the basal ganglia, and whether torticollis, like tortipelvis and other of the dystoniae, is due to lenticular nucleus disease. I think that there is disease in the basal ganglia of these patients. As Dr. Wycis has said, many of these patients have had psychiatric treatment without relief of a painful and disabling condition.

Later, as he also indicated, came the question of denervating the involved muscles by attacks upon the spinal nerves which innervate them, and the eleventh cranial nerve — the spinal accessory. Dr. MacKenzie of Toronto was, I believe, the first to suggest differential nerve section and has spent the most time in actually trying to identify the various muscle groups involved and performing selective sections, so that only those muscle groups involved might be denervated. He first sectioned the anterior roots of the first three cervical nerves, as well as the spinal accessory, in 1924. As Dr. Wycis has indicated, it may be possible to perform a differential section on one side or the other, depending upon which side seems to show the greatest involvement of the muscles. MacKenzie does make one point, which Dr. Wycis has also emphasized, which is that in his experience he has always had the best results when he has divided the first anterior cervical-nerve root.

I think that this, then, has been a gradual development in treatment, as our knowledge of this particular disease has developed — a disease which I believe has an organic pathology — by various methods and by various people interested in the problem to a point where these patients can be given relief as Dr. Wycis and Dr. Moore have shown.

It has been a pleasure for me to see this fine presentation of a subject which has been a difficult one; no single neurosurgeon has had a tremendous number of cases to study.

Dr. Wycis (closing): I wish to thank Dr. Loyal Davis for his discussion. One question arises about bilateral sectioning of the first, second, and third anterior roots, and spinal accessories within the dura. I think it is now well recognized that most patients have a bilateral involvement of the muscles, with one side predominating. If one sections one spinal accessory alone in the neck, the head may then turn to the other side, indicating involvement of the other side. Recently Herz and Hoefer have measured muscle potentials and have shown that in cases of spasmodic torticollis there is electromyographic evidence of muscular involvement of both sides.

DISCUSSION

The Cornpicker Hand

(*Continued from page 29*)

sarily conservative, frequently all that one can do in these injuries is to salvage as many fingers as possible, being conservative with those of doubtful blood supply. If the thumb escapes and the fifth finger can be saved, a very useful hand results. If the thumb escapes and all of the fingers must be disarticulated at the metacarpophalangeal joints, it is imperative to save the entire metacarpal area of the hand if possible. Even with all of the fingers missing, if the farmer has a good thumb and an intact metacarpus, he can do many types of heavy farm work.

The psychological effect of such major injuries of the hand on an active farmer is one of terrible depression, and the patient must get back to some degree of physical activity as soon as possible, even while the hand is still healing.

Dr. Carroll O. Adams, Mason City, Iowa: One point that I think it is important to stress is the psychological preparation of the patient for what he faces in the future. He is very often a young person and quite unstable; he comes into the hospital very much excited and greatly worried, knowing that the injury was his own fault. He should be shown that the ultimate mechanical function is the first consideration, with the cosmetic result secondary. He must be convinced that it is worth while to take time and energy and money in an attempt to save the hand. He should be told to start with that, if he is to get the maximum result, there may be multiple operations. One fortunate thing is that these patients have all winter in which to have this work done. The average farmer is least busy from October, when most of these injuries occur, until March or April. The hand should be in good condition by the time the spring plowing starts.

PROFILES OF THE CARPAL CANAL

BY JAMES N. WILSON, M.D., LOS ANGELES, CALIFORNIA

Some injuries and abnormalities of the carpal bones may be easily overlooked at routine roentgenographic examination. The anterior surface of the carpus is not completely visualized by the standard anteroposterior, lateral, and oblique roentgenograms, and many of the fine details of bone outline are lost because of the superimposition of one carpal bone upon another. A clearer definition of this area may sometimes prove revealing.

The most superficial of the bony prominences in the palm, and, consequently, those most vulnerable to direct trauma, consist of four anterior projections or pillars. These are represented on the radial margin by the tubercle of the navicular and the ridge of the greater multangular, and on the ulnar border by the pisiform and the unciform process of the hamate. The transverse carpal ligament spans between these pillars and thus converts the carpal canal into an osseofibrous tunnel. Through the tunnel pass nine digital flexor tendons and the median nerve. The tendon of the flexor carpi radialis also passes through the tunnel, but lies within a separate synovial compartment.

Figure 1 is a photograph of the hand showing the points at which the bony prominences may be palpated. The navicular tubercle and the ridge of the greater multangular are best felt upon radial deviation of the wrist. The pisiform is identified as the freely movable sesamoid lying within the tendon of the flexor carpi ulnaris. The palmar sensory branch of the ulnar nerve may be felt overlying the hook of the hamate.

FIG. 1

FIG. 2

Fig. 1: Photograph of a normal hand showing outline of the points at which the bony pillars of the carpal canal can be palpated. The proximal marking on the radial side represents the navicular tubercle and the distal marking, the ridge of the greater multangular. On the ulnar side the proximal outline denotes the pisiform and the distal outline marks the hook of the hamate.

Fig. 2: Photograph of the roentgenographic technique used in obtaining a profile view of the carpal canal. The wrist is dorsiflexed about 60 degrees, and the central ray is directed along the longitudinal axis of the third metacarpal.

Roentgenographic Technique

The roentgenographic outline of the bony pillars and their relationships to the carpal canal are well seen with an axial projection of the base of the palm. In 1941, Hart and Gaynor described the technique and showed roentgenograms of one case of "a developmental defect or separate hook of the hamate" and another case of either fracture or congenital defect in the hook of the hamate. Later in the same year, Hart reported a case of fracture of the ridge of the greater multangular identified by this method.

The technique of roentgenographic examination is shown in Figure 2. While the volar surface of the wrist is held against the cassette, the wrist is dorsiflexed 60 degrees, and the central ray is directed along the longitudinal axis of the third metacarpal. The osseous outline of the carpal canal is thus revealed in profile. Figures 3-A and 3-B, for comparative purposes, show a roentgenogram of a normal wrist, together with a photograph taken in the same axial plane of an anatomical specimen.

The following cases illustrate some of the alterations in the normal profile which may be produced as the result of either injury or developmental disturbances.

Defects Resulting from Injury

A fall on the outstretched hand or a crushing injury of the palm not infrequently results in fracture of the bony pillars or damage to the overlying soft tissues. The effect of such an injury may be the cause of persistent and unexplained pain in the palm. The complaint of pain and paraesthesia on the ulnar side of the hand, coupled with tenderness over the hook of the hamate bone, leads the examiner to suspect damage to the palmar sensory branch of the ulnar nerve. At this point, the nerve may be impinged against the underlying bony prominence.

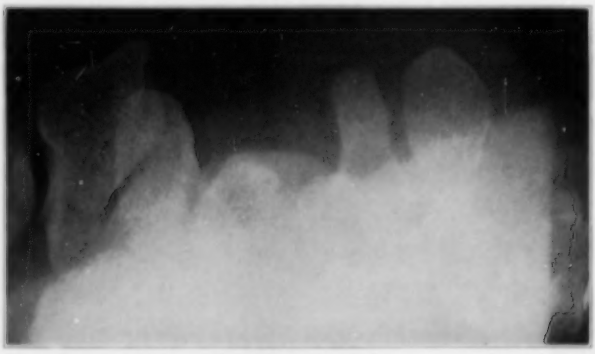

FIG. 3-A

FIG. 3-B

CASE 1. W. K., a man forty-nine years old, caught his right hand in a lathe. The long extensor tendon of the thumb and all digital extensor tendons were severed and the distal segment of the thumb was amputated. Subsequently, he regained good function of the hand, but continued to complain of tenderness along the ulnar border of the palm and hyperaesthesia of the little finger. Routine roentgenograms showed only a fracture of the ridge of the greater multangular. A profile view of the carpal canal shown in Figure 4 revealed, in addition, a fracture at the base of the hamate hook and a supernumerary carpal bone lying anterior to the bony pillars of the radial border.

Fig. 3-A: Roentgenogram of a normal wrist showing the profile view of the carpal canal.

Fig. 3-B: Photograph of an articulated anatomical specimen of the carpus as viewed in the axial plane from the radiocarpal joint. (The perforations of the lunate and navicular are artefacts.)

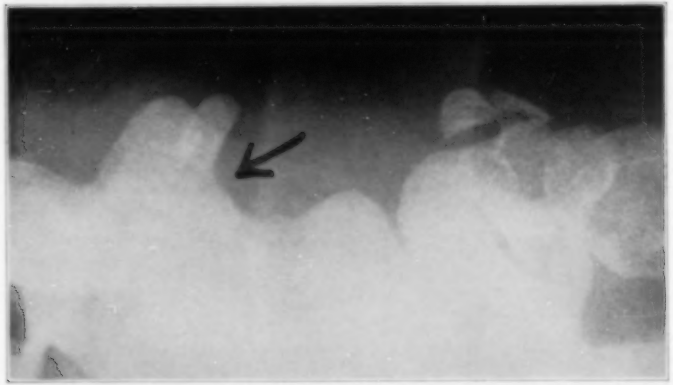

FIG. 4

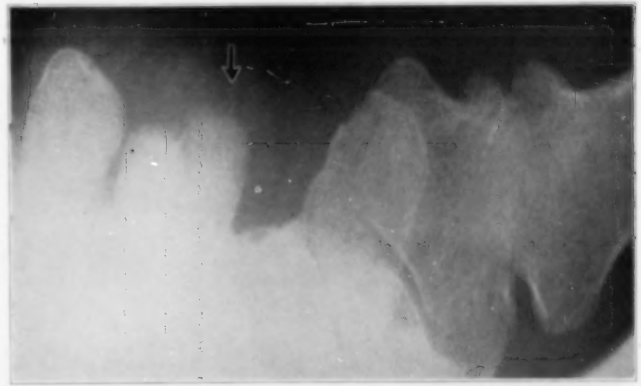

FIG. 5

Fig. 4: Roentgenogram showing a fracture of the base of the hook of the hamate (arrow) and a fracture of the ridge of the greater multangular. The supernumerary carpal bone lying adjacent to this ridge is termed a praetrapezium.

Fig. 5: Roentgenogram of the carpal canal showing an anterior dislocation of the lunate (arrow). The displaced lunate greatly reduces the size of the carpal tunnel and causes compression of its contents.

FIG. 6-A

Fig. 6-A: A congenital division of the capitate.

Fig. 6-B: Profile view showing encroachment of the carpal canal by the anomalous capitate.

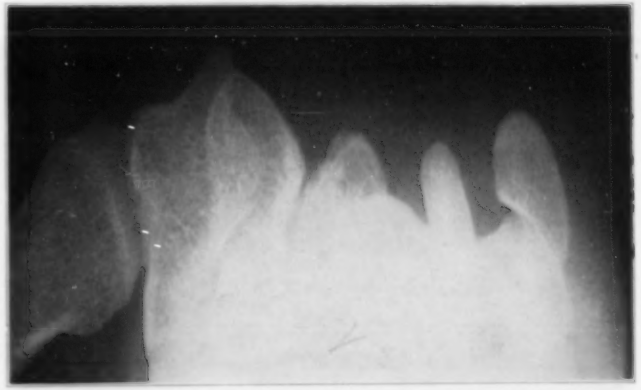

FIG. 6-B

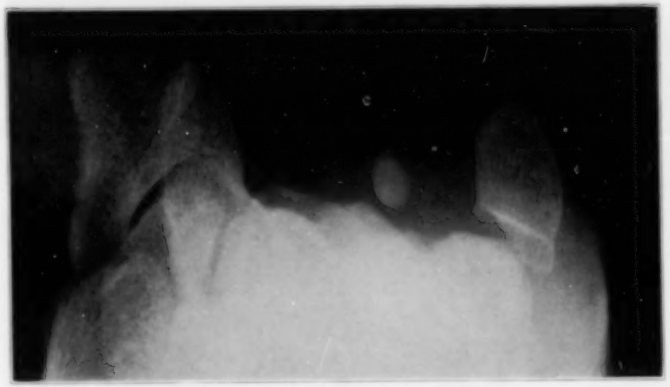

FIG. 7-A

FIG. 7-B

Fig. 7-A: Roentgenogram of the left wrist showing the result of failure in fusion of a separate ossification center of the hamate hook. (This might be confused with an ununited fracture.) Fig. 7-B: The opposite wrist of the same patient disclosed a similar developmental aberration.

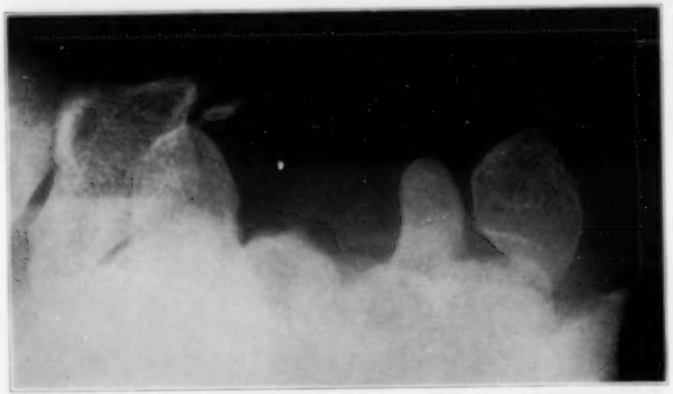

FIG. 8

FIG. 9

Fig. 8: The separate ossicle on the ulnar margin of the ridge of the greater multangular represents an avulsion fracture at the point of insertion of the transverse carpal ligament. Fig. 9: The profile roentgenogram revealed calcified pisiform bursitis.

Normally, the carpal tunnel is a fairly tight compartment, which allows only enough space for the nerve and the tendons which traverse it. Encroachment upon the tunnel may result in compression of the median nerve against the unyielding transverse carpal ligament or interference with the gliding mechanism of the flexor tendons. Chronic tenosynovitis thus produced may lead to spontaneous rupture of the flexor tendons.

Case 2. J. P., a man forty-seven years old, caught his left hand between the tire and the fender of a car when the jack slipped. Three months later, he complained of pain and impaired motion in the hand and wrist, as well as of numbness of the thumb, index, and long fingers. Examination further disclosed signs of median-nerve compression, including weakness of the thenar musculature. Routine roentgenograms revealed an anterior dislocation of the lunate. The extent to which the lunate encroached upon the carpal tunnel is shown in Figure 5.

Case 3. H. S., a man forty-one years old, noted a sharp pain in the right palm while he was climbing a telephone pole. During the following three months, there was a gradual loss of voluntary flexion of the distal two joints of the index finger. Physical examination revealed no sublimis or profundus action in the index finger. Standard roentgenograms (Fig. 6-A) revealed a bipartite capitate which on profile views (Fig. 6-B) was noted to project into the carpal tunnel.

In this case, there was no antecedent history of injury, and it is believed that the division of the capitate represents a congenital variation. It has not been possible to carry out surgery in this patient. However, it seems probable that spontaneous rupture of the index flexor tendons occurred as a result of attritional changes produced by gliding of the tendons over the anteriorly displaced portion of the capitate.

With a crushing injury of the palm in which the carpal arch is flattened, strong tension may be exerted on the transverse carpal ligament which is transmitted to its attachments on the bony pillars. It is unlikely that such a strong ligament would yield by rupture of its fibers. A more probable result is an avulsion fracture of the pillars at the points of insertion of the ligament.

Case 4. W. F., a man forty-four years old, caught his left hand and forearm between two steel rollers with a one-inch clearance. Two years afterward, he complained of some aching and cramping in the palm, radiating into the forearm. On examination, there was some mild, localized tenderness in the palm overlying the radial margin of the transverse carpal ligament. Routine roentgenograms were negative. Profile views (Fig. 8) showed a separate ossicle of bony density near the ulnar border of the ridge of the greater multangular, which gave the appearance of an ununited avulsion fracture at the point of insertion of the transverse carpal ligament.

Developmental Variations

According to most standard texts on osteology, each carpal bone develops from a single ossification center. Occasionally, however, a bone is formed from two centers of ossification which subsequently fuse. In these instances, if a failure of fusion results, a bipartite carpal bone is formed. This is usually recognized as such, if there has been a major division of the fragments; an example of this is noted in the bipartite capitate shown in Figures 6-A and 6-B. However, some confusion in interpretation may arise if the separate ossification zone of a bony appendage remains ununited.

The unciform process of the hamate bone not infrequently arises from a separate ossification center and occasionally fails to unite with the body of the hamate. Failure to recognize this may lead one to make a diagnosis of fracture of the hamate hook with non-union. If a developmental origin is suspected, roentgenograms of the opposite wrist may reveal a similar condition and support the diagnosis of the congenital nature of the defect.

Case 5. O. L., a man forty-six years old, fell on his outstretched right hand and received a fracture of the fourth metacarpal. He continued to have pain and tenderness on the ulnar side of the hand after the metacarpal fracture had healed. Profile roentgenograms of the right hand revealed a separate ossicle in the region of the hamate hook, which was believed to be an ununited fracture (Fig. 7-A). However, profile roentgenograms of the left wrist disclosed the same anomaly in the hamate bone (Fig. 7-B).

Supernumerary carpal bones, which are not seen on routine projections, may be visualized by this roentgenographic technique. In Figure 4, the separate ossicle lying adjacent to the greater multangular is interpreted as representing a praetrapezium. For a review of developmental anomalies of the carpus, the reader is referred to the monograph by Dwight.

Pisiform Bursitis

Between the pisiform bone and the tendon of the flexor carpi ulnaris lies a bursa which may become involved in an acute inflammatory process. Chronic irritation of the bursa may lead to fibrosis and subsequent calcification.[4] The calcified bursal deposits may be seen in the oblique roentgenogram, but are also well visualized with profile views.

Case 6. S. R., a man twenty-three years old, had been complaining of pain and tenderness on the ulnar border of his left hand for the past seven months. He recalled no specific injury. Oblique roentgenograms showed a calcific density overlying the pisiform bone, which was also well visualized in the profile view (Fig. 9).

SUMMARY

The author wishes to emphasize the importance of the profile view in identifying certain injuries and developmental disturbances of the carpus, since it is clear that standard roentgenographic views of the wrist do not reveal some of the fine details of carpal bones.

Note: The author wishes to express his gratitude to Dr. Joseph H. Boyes for his helpful suggestions and for providing the material presented in this article.

REFERENCES

1. Dwight, Thomas: A Clinical Atlas. Variations of the Bones of the Hands and Feet. Philadelphia, J. B. Lippincott, 1907.
2. Hart, V. L.: Two Unusual Injuries of the Wrist. J. Bone and Joint Surg., **23**: 948–949, Oct. 1941.
3. Hart, V. L., and Gaynor, Valena: Roentgenographic Study of the Carpal Canal. J. Bone and Joint Surg., **23**: 382–383, Apr. 1941.
4. Phalen, G. S.: Calcification Adjacent to the Pisiform Bone. J. Bone and Joint Surg., **34-A**: 579–583, July 1952.

DISCUSSION

Occult Derangements of the Medial Meniscus

(*Continued from page 118*)

been operated upon. Some have presented the syndrome in the form of acute post-traumatic symptoms which cleared completely without residua; others have had intermittent minimal symptoms with short clinical periods and long asymptomatic periods; still others have had the syndrome more continuously but with insufficient severity to warrant exploration. The group which we have presented was surgically treated only after they continued to have persistent crippling symptoms following a sufficient trial of all the standard methods of conservative treatment. Most of these patients had such symptoms not for days or weeks, but for months and even years.

We believe that this syndrome is a definite entity. We have tried to demonstrate what we feel is the pathological mechanism which produces this clinical picture. We believe that for selected patients with this syndrome, the treatment of choice is anteromedial arthrotomy and medial meniscectomy.

BRUCELLAR BURSITIS

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More than twenty-five years have elapsed since human infection with Brucella organisms was first recognized. In this span of time brucellosis has become the most common of the diseases transmitted from animals to man in the United States. Jordan and Borts, in their survey of the disease, gave the morbidity rate as 5.31 per 100,000 population in Iowa in the period 1935 to 1939, inclusive. The same authors made a similar study. They noted that the morbidity rate had increased to thirteen per 100,000 population for the period 1940 to 1944 inclusive. Braude and Spink, in 1950, attributed this increase of morbidity to the wartime increase in domestic livestock, reduced numbers of control agents owing to wartime demands, increase in the use of private abattoirs, and increased recognition of the disease and of its epidemiological nature. Whatever the cause for the apparent increase, brucellosis is today a factor to be reckoned with by physicians.

Historically, the statistical report of the British Army Medical Department for 1861, published by Marston, first differentiated Malta fever from other Mediterranean fevers. Bruce in 1887 discovered the causative organism of Malta fever by isolating it from the spleens after death from this disease. Bang in 1897 in Denmark recognized the organism that causes abortive fever in cows. Traum in 1914, working in the United States, isolated *Brucella suis;* but it remained for Evans in 1918 to demonstrate the similarity between the organisms of Bang's disease and those of Malta fever. A number of ambiguous terms based on the work of these four investigators have developed. Such terms as "Malta fever", "undulant fever", "milk fever", "infectious abortion", and many others have resulted. Suffice it to say that the present-day tendency in medical circles is to use the term "brucellosis" to refer to all forms.

Since brucellosis is transmitted to man from animals, the study of human brucellosis must of necessity include the study of brucellosis in animals. Epidemiologically, three main strains of the Brucella organism are recognized: *Brucella melitensis* in goats, *Brucella suis* in hogs, and *Brucella abortus* in cattle. Originally, it was felt that these three categories were inviolate and that cross infection did not occur. Huddleson in 1943, however, showed that cattle can be a reservoir for human infection and also that *Brucella suis* can affect cattle and that *Brucella abortus* may affect hogs. *Brucella abortus* is commonly thought to be the least virulent and least invasive of the three, and yet Spink in 1948 stated that this strain produces 80 per cent. of the cases of clinical brucellosis. Man may be infected with Brucella organisms in three ways. By far the most common is by the ingestion of raw milk from infected cows. The second is by skin contact such as occurs in stockyard workers, veterinarians, dairy men, packing-house workers, and laboratory workers. The third is perhaps by inhalation of dust which carries Brucella organisms.

Pathologically, brucellosis may appear as an acute, diffuse involvement of the body with multiple symptoms, or as a localized form. Spink was certain that a chronic form also exists, characterized by vague indefinite symptoms which may eventually culminate in a diagnosis of psychoneurosis. This form of the disease, he felt, will become more and more recognizable as our diagnostic aids improve. The acute diffuse form of brucellosis is manifested primarily by involvement of the reticulo-endothelial system, but other organs are not spared. Thus one sees ophthalmic changes, neuritis, arthralgia and myalgia,

changes in the central nervous system, and so forth, as well as the customary findings. Microscopically, the reaction varies considerably. In some cases it is that of a chronic inflammatory process, and in other cases it may simulate that of tuberculosis.

The concomitant occurrence of brucellosis and other disease entities has been noted. Spicknall and his coworkers could find no concrete proof of interrelation between brucellosis and multiple sclerosis, even though this had been proposed by Kyger and Haden. Eisele, McCullough, and Beal also refuted this proposal. Brucella organisms have been said to be the cause of Hodgkin's disease and of rheumatoid arthritis, but this has not been proved.

The localized form of brucellosis is the type we wish to stress in this paper. Localized involvement of joints has been reported by Coventry and his coworkers, Robecchi, Sharpe, Hardy and coworkers, and many others. Brucellar osteomyelitis was first reported by Kulowski and Vinke (1932), and later described in more detail by Steindler (1940), and by Lowe and Lipscomb (1947). However, not much information is found in the literature regarding involvement of the bursae of the human body with Brucella organisms. According to Donald, a condition referred to as fistulous withers in horses has long been recognized by veterinarians as due to brucellar infection of the large bursa overlying the withers. In man, however, brucellar bursitis seems rare. Hardy and his coworkers stated that, because of the many varieties of brucellosis already recognized, one could expect to encounter bursal involvement also. Kennedy described bursitis and synovitis due to brucellosis and reported a case of subdeltoid bursitis in which the organism was isolated from the bursal aspirations. Harris mentioned three cases of popliteal bursitis due to brucellosis, but none of these were verified by culture.

From a cursory review of the literature on the disease, one is impressed with the generalized form of brucellosis. However, we feel that, as brucellosis becomes more prevalent, the localized forms of the disease will become more evident. Hence, we are reporting the following four cases of brucellar bursitis.

REPORT OF CASES

Case 1. A farmer, sixty-three years old, reported to the Mayo Clinic on February 15, 1952, complaining of swelling over the anterior aspect of the right knee joint of five to six years' duration. This swelling had first appeared without definite trauma aside from the usual kneeling he did in his everyday work on the farm. There was no pain, redness, or local heat. Four years prior to admission the swollen site had been aspirated repeatedly and on each occasion a grayish fluid had been recovered in which "rice bodies" were floating. Four months prior to admission the patient had influenza, after which the swelling in his knee had increased and there was soreness to touch. Local heat was also present. He received several injections of penicillin without benefit. The past history revealed nothing that would lead to a diagnosis of brucellosis. The patient did volunteer that one of his dairy cows had tuberculosis in 1935 and had to be disposed of.

On examination there was hydrops of the right prepatellar bursa which was rated as Grade 3 (on the basis of 1 to 4) (Figs. 1-A and 1-B). No heat or redness was noted and there was a normal range of motion in the

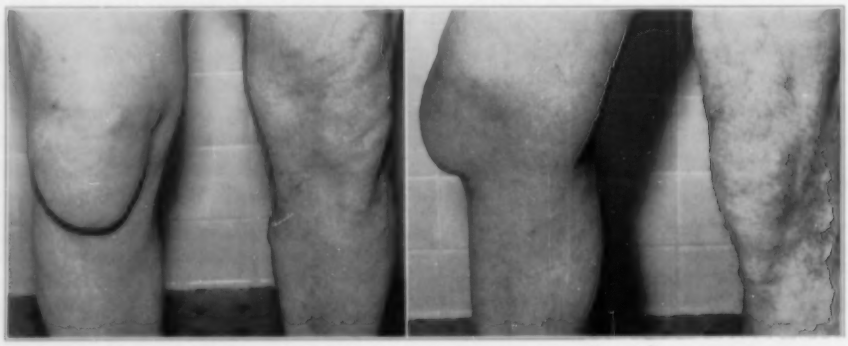

Fig. 1-A Fig. 1-B

Case 1. February 20, 1952. Front and side views of the enlargement of the right prepatellar bursa.

right knee. The temperature was 98.4 degrees Fahrenheit. Urinalysis gave negative results, as did routine examinations of the blood. The sedimentation rate was eighteen millimeters in one hour (Westergren method) and the Kline flocculation reaction for syphilis was negative. Brucella organisms were agglutinated in a titer of 1 to 1,600. Roentgenograms revealed a periarticular soft-tissue swelling anterior to the right knee joint, but the osseous structures comprising this joint were normal.

On February 20, 1952, eight cubic centimeters of orange-colored fluid was aspirated from the prepatellar bursa. Two smears were negative for acid-fast organisms, as were routine cultures of the material obtained.

On February 26, the right prepatellar bursa was excised. The pathologist reported the presence of subacute granulomatous bursitis, the bursa measuring ten by eight by four centimeters (Fig. 1-C). Postoperatively the patient was given three grams of aureomycin and one gram of dihydrostreptomycin per day for a total of thirty days. He was dismissed from the Hospital on March 17, 1952. At that time the wound was healed and he was moving about with the aid of a cane. He continued his antibiotic regimen at home under the direction of his family doctor and was last seen on August 18, 1952, six months after operation, at which time he was doing well and had no complaints (Figs. 1-D and 1-E).

Brucella abortus was recovered from the material taken at the time of operation on February 26, 1952.

Case 2. A sixty-year-old farmer first came to the Mayo Clinic in March 1951, complaining of swelling over the anterior aspect of the right knee of eight months' duration. This swelling had come on insidiously and without trauma. Since its inception he had noted no redness or local heat. Six times the swollen region had been aspirated and each time clear yellow fluid had been removed. Six weeks prior to admission the patient had noted the development of a movable nodule above the right patella and just proximal to the site of effusion. The patient had no symptoms other than the swelling and some pain, which was present when the swelling was greatly increased. His past history revealed that a ganglion on the lateral aspect of the right ankle had been removed five months previously and that a productive cough had been present for the past two years, producing a yellow mucoid sputum. The patient also stated that a few of his hogs had died in the summer of 1950 of "some sort of fever".

Physical examination revealed hydrops of the right prepatellar bursa but full range

Fig. 1-C

February 27, 1952. Cross section of the bursa removed surgically. Note the fibrin-filled cavity and especially the marked thickening of the bursal wall.

Fig. 1-D Fig. 1-E

August 18, 1952. Front and side views of the knee six months after operation.

of motion in the joint. Proximal to the patella there was a movable nodule 0.5 centimeter in diameter which was believed to be situated within the quadriceps tendon. The temperature was 98.6 degrees Fahrenheit and the only other remarkable fact was the presence of moderate pallor. The urine and blood were normal. The urea measured twenty-six milligrams per 100 cubic centimeters of blood, and the flocculation reaction for syphilis was negative. The sedimentation rate was thirteen millimeters in one hour (Westergren method). A roentgenogram of the thorax revealed a Ghon complex, while that of the right knee revealed swelling of the prepatellar bursa together with vascular calcification of the right lower extremity. Because all the factors in the patient's history pointed toward tuberculosis, this was the preoperative diagnosis.

On March 9, 1951, the right prepatellar bursa and the nodule just proximal to it were excised. The pathologist reported that the prepatellar bursa was inflamed, measuring four centimeters in diameter and containing numerous rice bodies; that the inflammatory reaction was probably tuberculous, although no actual tubercles were found, and that the nodule from the region of the right knee was tuberculous and contained multiple rice bodies. *Brucella abortus* was cultured from the tissues taken at operation, but the routine cultures, acid-fast smears, cultures for fungi, and guinea-pig inoculations from these sections all gave negative results. The wound healed by first intention and the patient was dismissed from the Hospital on the eighth postoperative day.

On March 22, because of the positive culture, the patient was started on treatment with three grams of aureomycin and one gram of dihydrostreptomycin given daily. He was advised to continue this treatment for twenty-one days. When he was last seen, in April 1951, he still had some swelling and pain but stated that he was slowly improving. Agglutination for Brucella organisms, determined on March 20, 1952, was positive in a dilution of 1 to 400.

Case 3. A forty-year-old farmer came to the Mayo Clinic in February 1951, complaining of a tumor over the left knee of fourteen years' duration. Fourteen years previous to admission this patient had had indefinite trauma to the anterior aspect of the left knee and had noted that pain and swelling were present immediately thereafter. Fullness had been present in this region during the ensuing years. Ten to twelve years previously a considerable amount of fluid had been aspirated on several occasions. The patient had noted, eight to nine years before admission, that the tumor had tended to become less fluctuant. Eight years previous to admission Bang's disease had been discovered in the patient's cows and hogs; prior to that time it had been the patient's habit to drink raw milk from his own cows.

Examination revealed hydrops of the prepatellar bursa on the left, the affected part measuring about four inches (ten centimeters) in diameter. Function of the knee was normal and the temperature was 97.4 degrees Fahrenheit. The urine and blood were normal. The sedimentation rate was twenty-three millimeters in one hour (Westergren method), and the Kline flocculation reaction was negative. A roentgenogram of the thorax revealed a Ghon complex, while that of the left knee disclosed marked prepatellar soft-tissue swelling, the osseous structure appearing normal.

On February 8, 1951, the prepatellar bursa of the left knee was excised. The pathologist reported the presence of chronic bursitis, the sac measuring 7.5 by 7.5 by 3.5 centimeters; the bursa was filled with fibrin and the densely fibrotic and inflammatory wall averaged 0.4 centimeter in thickness. Cultures of the specimen removed at operation were negative for fungi and acid-fast organisms but positive for *Brucella abortus*. Two blood cultures for Brucella were negative.

Thirteen days postoperatively the wound had healed. Fourteen days postoperatively agglutination for Brucella organisms was negative; agglutination tests had not been made preoperatively. The patient did not report for postoperative follow-up.

Case 4. A farmer, thirty-six years old, was seen at the Clinic in March 1951, complaining of swelling about the right knee of three years' duration. The swelling had been intermittent in character. It had always been situated over the anterior aspect of the knee joint, and for the past year it had been present continuously. Multiple aspirations of the swelling had been carried out, but the swelling always returned some hours after aspiration. He had noted no pain or reduced function. The past history revealed pyelonephritis which had required hospitalization in 1945; at that time agglutination for Brucella organisms gave negative results. The family history, as well as the agricultural history, was non-contributory.

Examination revealed an enlarged, fluid-filled, prepatellar bursa throughout which loose bodies could be palpated. The overlying skin was bluish. The motion of the right knee was judged to be normal. There was Grade 1 pyuria. The blood was normal and the Kline flocculation reaction for syphilis was negative. The sedimentation rate (Westergren method) was three millimeters in one hour. Roentgenograms of the thorax did not disclose any abnormality. There was marked swelling of the right knee in the region of the prepatellar bursa. The osseous structures of the right knee joint were normal.

On March 22, 1951, the right prepatellar bursa was removed. The pathologist reported the presence of prepatellar bursitis of traumatic origin; the sac was filled with yellow fluid and fibrin, and the walls were the site of mild inflammatory infiltration. The wound was healed on April 9, 1951, but there was a small amount of fluid beneath the site of the wound. Cultures of this fluid for acid-fast organisms and for fungi, as well as

routine cultures, were negative. Acid-fast organisms were not found in smears. However, a culture of the specimen removed at operation was positive for *Brucella abortus*. The agglutination reaction for Brucella determined on April 9, 1951, was positive in a titer of 1 to 50. The patient was given three grams of terramycin and one gram of dihydrostreptomycin a day for three weeks, and he was on this program when he left the Clinic. However, six days after his last visit, the fluid had completely disappeared from the site of operation in the right knee and as a consequence the patient stopped therapy. He returned to the Clinic in January 1952, approximately nine months after his operation, at which time fluid was again present beneath the scar. This fluid was aspirated on January 3, 1952, but culture gave negative results.

DIAGNOSIS

Cursory review of the cases presented above demonstrates that the diagnosis of brucellosis, even in the presence of a good history of contact, is not easy. Probably the most important asset in making the diagnosis is an awareness, on the part of the physician, that this disease may be present in its localized, as well as its generalized, form. An important diagnostic aid is the culture of venous blood. The agglutination test has been used extensively in the diagnosis of brucellosis, but opinions have varied as to how high the titer must be to make agglutination significant. Evans has said that agglutination in a titer of 1 to 40 is significant. Braude and Spink, as well as other well known authorities, have expressed the opinion that a titer of 1 to at least 80 and preferably higher is necessary before one can entertain more than a suspicion of brucellosis.

Intradermal tests with Brucella antigen (brucellergen) have been used for the diagnosis of brucellosis, but, according to Spicknall and his coworkers, criteria for the intelligent use of such tests have not been adequately established. Spink and Hall have said that the intradermal test for the presence or absence of Brucella is the "most abused diagnostic procedure" used by the average physician. It has been condemned by the National Research Council because of its variable reaction and the difficulty in performing the test properly. Moreover, a Brucella antigen of constant strength is not available. Hence there is considerable variability in interpretation of the results of the test. Lastly, the opsonocytophagic test as originally advanced by Huddleson has been discarded almost entirely, since its results are too variable to be reliable. In the diagnosis of brucellosis, the final and conclusive proof of the presence of infection is isolation of the organism either from the tissue removed or from blood cultures. To a lesser degree, Brucella can be isolated from bile and urine, but these are not very reliable sources of the organism.

TREATMENT

The treatment of brucellosis can be divided generally into two phases: medical and surgical. For the generalized form of the disease, treatment with aureomycin and dihydrostreptomycin (three grams of the former and one gram of the latter given daily in divided doses for a period of thirty days) has been offered by Herrell and Barber [13] and by Heilman. In the past treatment has consisted of the administration of sulfadiazine, aureomycin, terramycin, and chloramphenicol, singly or in combination, as was brought out by Knight, Spink and Hall, and Ploussard. The generally accepted method of medical treatment at present is that suggested by Herrell and Barber [14].

The surgical treatment of brucellosis has to do with basic surgical concepts of drainage of infected regions. In our four patients a fair amount of fibrosis was present in all the specimens removed at operation. It seems unlikely that any amount of antibiotics would penetrate this protective layer of fibrosis. Therefore, we think that medical treatment of brucellosis should be combined with surgical excision of the lesions whenever such excision seems advisable. Certainly in these four patients, in whom truly localized lesions were present, we feel that surgical excision of the localized lesions was indicated.

SUMMARY

The four cases we have reported illustrate several interesting points. As was brought out by Coventry and his coworkers in their report of a case of *Brucella suis* infection of the

hip in 1949, and as was further demonstrated in one of our cases, the results of Brucella cultures of aspirated fluid from a site of Brucella infection are many times reported as negative, while cultures of tissue taken from the same site give positive results. The results of the agglutination test for Brucella, when positive, are not significant enough to establish a diagnosis of localized brucellosis. We feel that the only certain way to make a diagnosis of brucellosis is by isolation of the organism; in patients with localized lesions, this is best done by bacteriological examination of the tissue removed at operation. Cultures of such tissue in our hands have given a more reliable basis than any other type of culture for making a positive diagnosis of brucellosis. This fact has already been emphasized [32].

Lastly, we wish to stress the point that localized lesions do occur and represent a definite clinical entity. The most important factors leading to the diagnosis of brucellosis are: (1) a suspicion that such an infection is present, and (2) actual bacteriological isolation of the organism.

REFERENCES

1. Bang, B.: Die Aetiologie des seuchenhaften ("infectiösen") Verwerfens. Zeitschr. f. Thiermed., **1**: 241–278, 1897.
2. Braude, A. I., and Spink, W. W.: Brucellosis. *In* Advances in Internal Medicine, **4**: 163–200, 1950.
3. Bruce, David: Note on the Discovery of a Micro-Organism in Malta Fever. Practitioner, **39**: 161–170, 1887.
4. Coventry, M. B.; Ivins, J. C.; Nichols, D. R.; and Weed, L. A.: Infection of the Hip by Brucella Suis. J. Am. Med. Assn., **141**: 320–325, 1949.
5. Donald, D. E.: Personal communication.
6. Eisele, C. W.; McCullough, N. B.; and Beal, G. A.: Brucellosis and Multiple Sclerosis. J. Am. Med. Assn., **143**: 1473–1474, 1950.
7. Evans, A. C.: Further Studies on Bacterium Abortus and Related Bacteria. II. A Comparison of Bacterium Abortus with Bacterium Bronchisepticus and with the Organism which Causes Malta Fever. J. Infect. Dis., **22**: 580–593, 1918.
8. Evans, A. C.; Robinson, F. H.; and Baumgartner, Leona: Studies on Chronic Brucellosis. IV. An Evaluation of the Diagnostic Laboratory Tests. Pub. Health Rep., **53** (2): 1507–1525, 1938.
9. Hardy, A. V.; Jordan, C. F.; Borts, I. H.; and Hardy, G. C.: Undulant Fever. With Special Reference to a Study of Brucella Infection in Iowa. Pub. Health Rep., **45** (2): 2433–2476, 2525–2572, 1930.
10. Hardy, A. V.; Jordan, C. F.; Borts, I. H.; and Hardy, G. C.: Undulant Fever, with Special Reference to a Study of Brucella Infection in Iowa, p. 58. (National Institute of Health Bulletin No. 158, 1931.) United States Treasury Department, Public Health Service, 1931.
11. Harris, H. J.: Brucellosis (Undulant Fever) Clinical and Subclinical, p. 79. New York, Paul B. Hoeber, Inc., 1941.
12. Heilman, F. R.: The Effect of Combined Treatment with Aureomycin and Dihydrostreptomycin on Brucella Infections in Mice. Proc. Staff Meet. Mayo Clin., **24**: 133–137, 1949.
13. Herrell, W. E., and Barber, T. E.: The Combined Use of Aureomycin and Dihydrostreptomycin in the Treatment of Brucellosis. Proc. Staff Meet. Mayo Clin., **24**: 138–145, 1949.
14. Herrell, W. E., and Barber, T. E.: A New Method for Treatment of Brucellosis. J. Am. Med. Assn., **144**: 519–523, 1950.
15. Huddleson, I. F.: Brucellosis in Man and Animals. Rev. Ed. New York, The Commonwealth Fund, 1943.
16. Jordan, C. F., and Borts, I. H.: Brucellosis and Infection Caused by Three Species of Brucella. Clinical, Laboratory and Epidemiological Observations. Am. J. Med., **2**: 156–167, 1947.
17. Kennedy, J. C.: Notes on a Case of Chronic Synovitis, or Bursitis, Due to the Organism of Mediterranean Fever. J. Roy. Army Med. Corps, **2**: 178–181, 1904.
18. Knight, Vernon: Chemotherapy of Brucellosis. Ann. New York Acad. Sciences, **53**: 332–344, 1950.
19. Kulowski, Jacob, and Vinke, T. H.: Undulant (Malta) Fever Spondylitis. Report of a Case, due to Brucella Melitensis, Bovine Variety, Surgically Treated. J. Am. Med. Assn., **99**: 1656–1659, 1932.
20. Kyger, E. R., Jr., and Haden, R. L.: Brucellosis and Multiple Sclerosis. Cutaneous Reactions to Brucella Antigens. Am. J. Med. Sciences, **216**: 689–693, 1948.
21. Lowe, G. H., Jr., and Lipscomb, P. R.: Brucellosis Osteomyelitis. Report of Two Cases in Which Shafts of the Long Bones Were Involved. Surgery, **22**: 525–529, 1947.
22. Marston, J. A.: Report on Fever (Malta). Army Med. Dept. Statist. Rep., 1861, London, **3**: 486–521, 1863.
23. National Research Council: Report of Subcommittee on Public Health Aspects of Brucellosis. Bethesda, Maryland, May 9–10, 1949.

24. Ploussard, C. N.: Brucella Infection of Bones and Joints. Am. J. Roentgenol., **66**: 910–914, 1951.
25. Robecchi, Alessandro: Artropatie brucellari. Minerva Med., **42** (2): 973–993, 1951.
26. Sharpe, J. C.: Intermittent Hydrarthrosis Associated with Undulant Fever. Ann. Int. Med., **9**: 1431–1436, 1936.
27. Spicknall, C. G.; Kurland, L. T.; Carle, B. N.; and Terry, L. L.: Relation of Brucellosis and Multiple Sclerosis. J. Am. Med. Assn., **143**: 1470–1473, 1950.
28. Spink, W. W.: Pathogenesis of Human Brucellosis with Respect to Prevention and Treatment. Ann. Int. Med., **29**: 238–258, 1948.
29. Spink, W. W., and Hall, W. H.: The Diagnosis and Treatment of Brucellosis. Med. Clin. North America, **29**: 343–362, 1945.
30. Steindler, Arthur: Orthopedic Complications of Brucellosis. J. Iowa Med. Soc., **30**: 256–257, 1940.
31. Traum, J.: Infectious Abortion Investigation in Pigs. Ann. Rep. U. S. Dept. of Agric., **86**, 1914.
32. Weed, L. A.; Dahlin, D. C.; Pugh, D. G.; and Ivins, J. C.: Brucella in Tissues Removed at Surgery. Am. J. Clin. Pathol., **22**: 10–21, 1952.

AVULSION OF THE TENDON OF THE SUBSCAPULARIS MUSCLE

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Tears of the supraspinatus are well recognized. Minor tears of the subscapularis have been observed at the time of operation for repair of tears of the supraspinatus.

In discussing ruptured supraspinatus tendons, Codman stated: "Occasionally the tear crosses the bicipital groove and involves the subscapularis portion of the conjoined tendon". He had found, in one dissecting-room specimen, that the tear extended inward from the groove and involved the subscapularis portion alone. According to statistics from the Library of the Surgeon General, muscles about the shoulder, other than the supraspinatus and the biceps, are seldom injured.

Smith reported a case in 1834, which at the time of dissection revealed a tear of the subscapularis from the lesser tubercle, while the other muscles were intact.

In two cases of avulsion of the subscapularis tendon seen by the author, the fascial covering was intact and the avulsion was recognized only after the subscapularis muscle was exposed. Interestingly enough, both cases occurred within a few months of each other, and both patients complained primarily of recurrent dislocation of the shoulder. Apparently subscapularis avulsion is not a common cause of recurrent dislocation since, if it were present, it would be revealed by the Putti-Platt type of operation which has been done many times. Evidently, the avulsion of the subscapularis muscle is a rare condition.

CASE REPORTS

Case 1. J. M., a man twenty-one years old, complaining of recurrent dislocation of the shoulder, was first seen on June 22, 1951. In October 1945, he had fallen while playing football. The shoulder had dislocated at the time and was reduced. Thereafter he had had several dislocations each year. At first he was able to reduce the dislocation himself. Later, reductions were made by an athletic director and by a surgeon. The history and physical examination were otherwise negative. X-ray findings were normal; there was no defect in the humeral head.

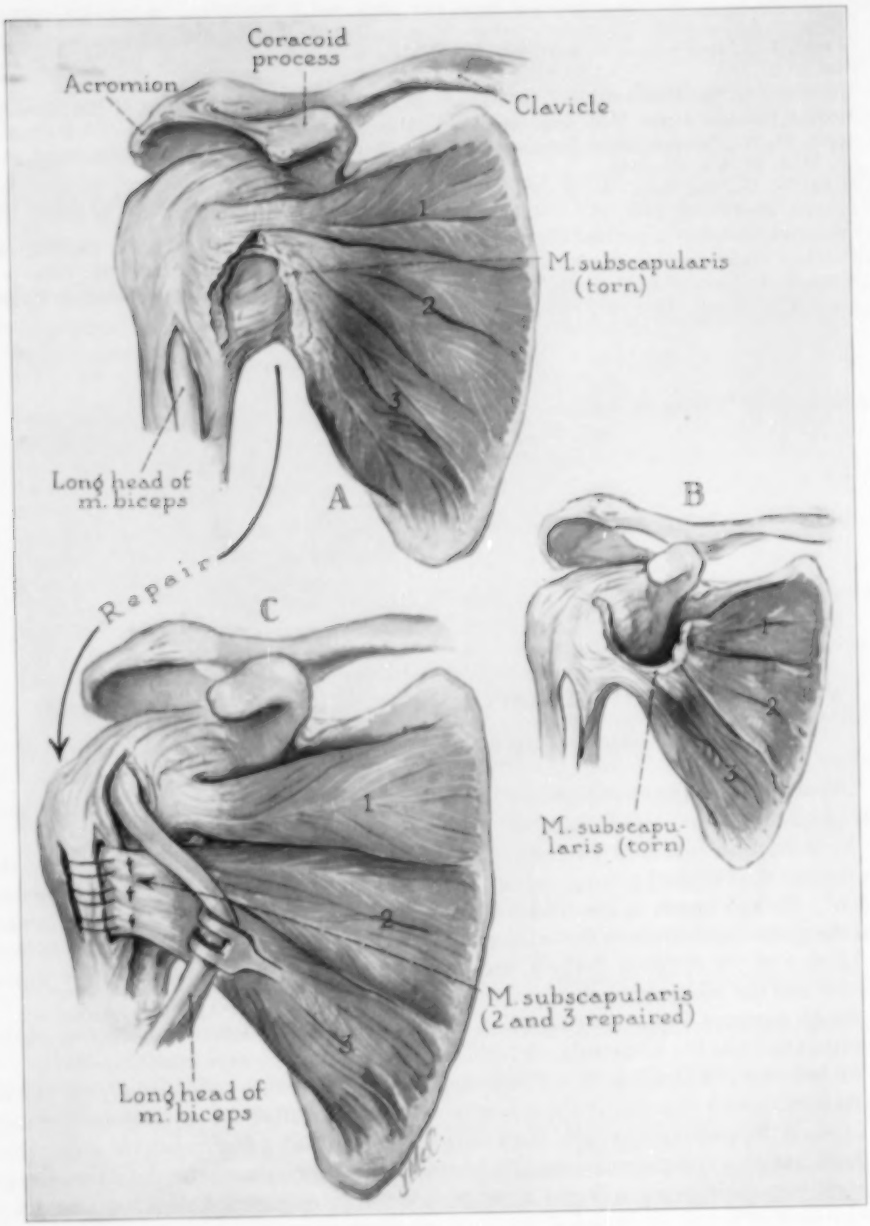

FIG. 1

A: Shows a large tear of the lower part of the subscapularis muscle.
B: Shows a lesion in which the upper part of the subscapularis muscle was torn.
C: Shows the method of attaching the torn muscle to the humerus.

On June 28, 1951, under general anaesthesia, an incision was made along the deltopectoral groove from the clavicle distally for about nine centimeters. The superior portion of the pectoralis major was detached from the humerus. The pectoralis major, the deltoid, the coracobrachialis, and the biceps were retracted, and the subscapularis was exposed. The subscapularis was found to be torn from its attachment to the humerus except for the lower fifth. The avulsed portion had been retracted so that it was not visible at first.

The capsule of the shoulder joint was then exposed and movements were carried out to ascertain its strength. The glenoid rim was palpated; it was felt to be intact. The biceps tendon was freed from its groove and retracted.

With a sharp osteotome a groove was cut in the humerus about one centimeter lateral to the bicipital groove, 3.8 centimeters in length and 0.6 centimeter in depth. The osteotome was passed through the cortex of the bone obliquely 0.6 centimeter lateral to this groove so as to connect with the groove and leave a shelf of bone between the two openings. The torn, retracted subscapularis tendon was then freed and drawn under the biceps tendon and into the groove. Here it was fixed to the bone with five mattress sutures which were passed through the tunnel created in the bone, over the bridge of bone, and again fixed to the tendon and tied (Fig. 1, *C*). During the whole procedure the humerus was kept in internal rotation so that the subscapularis firmly re-enforced the entire capsule of the shoulder joint in this area. The arm was fixed with a Velpeau bandage.

The patient made an uneventful recovery. He was in the hospital for twelve days. Abduction up to 90 degrees was accomplished at four weeks. Exercises to strengthen the internal rotator muscles were started at six weeks. At six months he was using the arm normally and had a full range of motion except for slight limitation of external rotation. The only limitation in activity at that time was that he was not permitted to play football. He passed the examination for the Air Force and at present is in active service and is able to participate in all major sports.

Case 2. W. M., a man twenty-one years old, was seen on June 14, 1951. He gave a history of recurrent dislocation of the left shoulder over a period of six months. The first dislocation occurred when he fell from an embankment. A month later, while playing volleyball, he redislocated the shoulder. Since that time the shoulder had been dislocated fifteen times, usually during some athletic activity but more recently while he was asleep. At first, reduction was simple, but it had become increasingly difficult.

The roentgenologist reported two small areas of irregularity in the region of the greater tuberosity, frequently associated with dislocation. The history and physical examination were otherwise negative.

On July 5, 1951, an 8.8-centimeter incision was made above the deltopectoral groove from the region of the acromioclavicular process. It was not necessary to sever the upper attachment of the pectoralis major as in Case 1, and after the coracobrachialis had been retracted, the subscapularis tendon was exposed. The subscapularis was found to be completely avulsed except for a small band at its upper portion about one centimeter in width. Except for this band, the entire muscle was torn away from its attachment to the humerus. The torn part of the muscle had retracted and was very fragile and atrophic. The labrium glenoidale was palpated and seemed intact. With an osteotome a groove was made for a new attachment of the subscapularis muscle just lateral to the biceps tendon as in Case 1. The biceps tendon was then freed so that the subscapularis could be drawn beneath it. Interrupted mattress sutures of chromic catgut, passed through drill holes, were used to draw the torn part of the muscle into contact with the raw bone of the new groove in order to make the attachment more solid. The shoulder was held by means of a Velpeau bandage.

The patient left the hospital on the twelfth postoperative day; at three weeks, abduction to a right angle was started. At five weeks a six-pound weight could be lifted in abduction. He was checked again after six months at which time he was using the arm normally.

He progressed satisfactorily, taking part in athletics until about a year after the operation. At that time he began to notice an occasional subluxation when the arm was completely relaxed. When he was last seen in December 1952, the shoulder could be locked with the subscapularis so that it would not dislocate; but, with the muscles relaxed and the arm in abduction and external rotation, a subluxation could occur. A second operation was advised.

In this instance, the avulsion of the muscle was probably not the only cause of the dislocation. For this reason it is probably advisable, in every case of recurrent dislocation of the shoulder associated with avulsion of the subscapularis muscle, to combine the repair and shortening of the muscle with a shortening of the capsule similar to that used in the Putti-Platt operation, or suture of the capsule to the glenoid rim after the manner of Bankart.

REFERENCES

1. Codman, E. A.: The Shoulder, p. 84 and p. 502. (Privately printed.) Boston, Thomas Todd Co., 1934.
2. Smith, J. G.: Pathological Appearances of Seven Cases of Injury of the Shoulder-Joints, with Remarks. (Abstract from The Medical Gazette, May 1834.) Am. J. Med. Sciences, **16**: 219–224, 1835.

MODIFICATION OF THE POSTEROLATERAL APPROACH TO THE HIP FOR INSERTION OF FEMORAL-HEAD PROSTHESIS

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Several posterior approaches to the hip have been described in the literature. The authors have modified the approach described by Gibson for patients requiring the insertion of a femoral-head prosthesis. They have found it a rapid and almost bloodless approach which gives excellent visualization of the posterior joint. The Judet prosthesis and also that described by Frederick R. Thompson have been used in various cases; each has been inserted in this manner without difficulty. The entire procedure takes less than one hour.

TECHNIQUE OF OPERATION

The patient is placed on the sound side in the lateral position, secured by kidney supports and a strip of three-inch adhesive tape across the flank. The affected extremity is draped so that it may be freely handled during the procedure. The angulated skin incision is centered over the greater trochanter. The distal limb of the incision extends along the line of the femur for about fifteen centimeters, and the proximal limb of the incision (about twelve to fifteen centimeters long) angulates posteriorly from the tip of the greater trochanter toward a point which is three fingerbreadths anterior to the posterior superior iliac spine. The fatty subcutaneous layer is incised to expose the dense gluteofemoral fascia. This fascia is next incised in the lower limb of the incision, in line with the femur. The trochanteric bursa is opened and the gluteal fascia is incised along the anterior border of the glutaeus maximus to deepen the proximal limb of the incision. This brings into clear view the external rotators of the hip and the greater trochanter. The next step is to divide these muscles, namely the piriformis, gemelli, obturator internus, and part of the quadratus femoris, in line with the femoral shaft, leaving a cuff of muscle at their insertion to facilitate later re-attachment. The gluteal muscles are not disturbed. Retraction of the external rotators reveals the posterior hip capsule, which is then incised or resected to expose the joint. If the case is one of fresh subcapital fracture, the femoral head is then removed; if the case is one of arthritis or avascular necrosis, the neck is osteotomized and then the head is removed. If desired, the hip may be dislocated posteriorly by flexion and internal rotation of the extremity. Following the removal of the head, the extremity is internally rotated to bring the neck into full view. The acetabulum is fully exposed for reaming at this time if it is necessary. The neck is prepared and the prosthesis is inserted with the extremity fully internally rotated; then the hip is reduced by traction, flexion, and external rotation.

In closure, the capsule may be sutured without difficulty. The rotator muscles are approximated. The next and most important layer, the gluteofemoral fascia, is closed and the subcutaneous tissue and skin fall together without difficulty.

Since the position of rest is one of external rotation, we feel that the unfortunate complication of dislocation of the prosthesis is less apt to occur if a posterior approach is used than with the anterior type. The incision passes between adjacent nerves, thus producing no unpleasant areas of anaesthesia. The only muscles transected are those of the rotator group, where bleeding is not a problem; seldom are more than one or two ligatures required.

We have found that this modification of the time-honored Kocher incision gives excellent visualization of the hip joint and allows the introduction of a femoral-head prosthesis without difficulty.

This approach has been utilized by the authors while operating upon twenty patients.

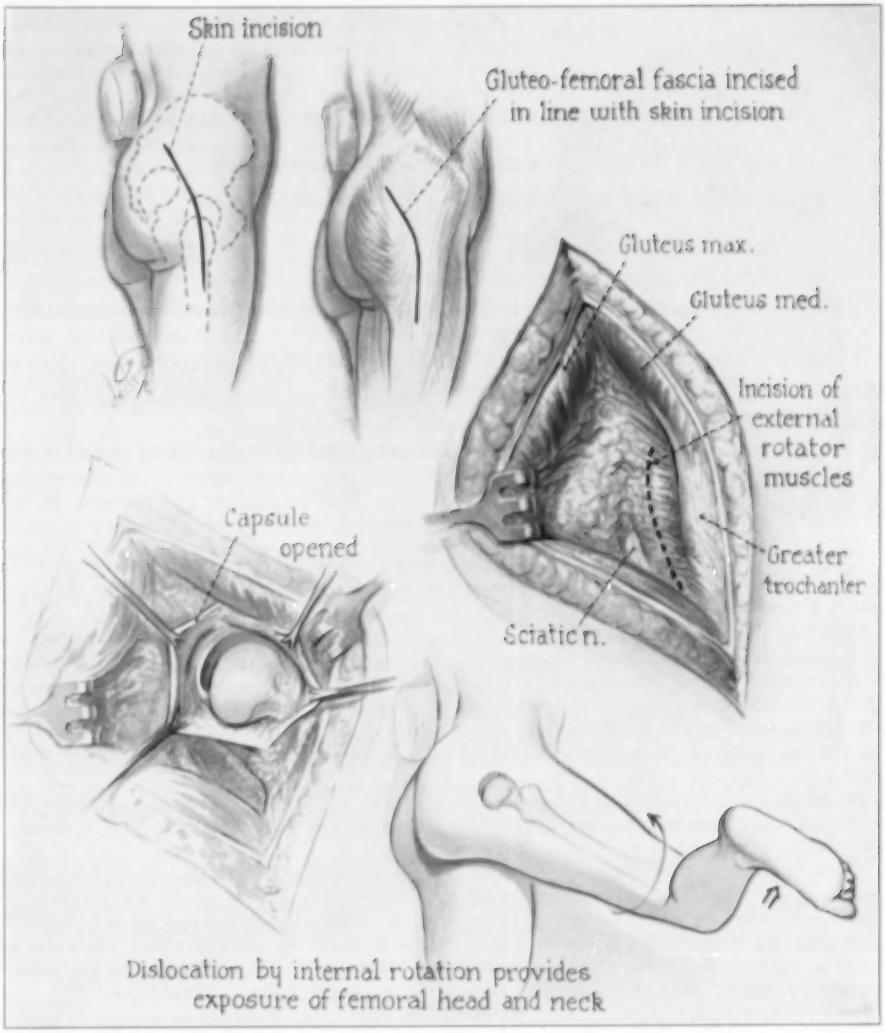
Skin incision
Gluteo-femoral fascia incised in line with skin incision
Gluteus max.
Gluteus med.
Incision of external rotator muscles
Capsule opened
Greater trochanter
Sciatic n.
Dislocation by internal rotation provides exposure of femoral head and neck

FIG. 1

The conditions for which it was selected included severe osteo-arthritis of the hip joint, aseptic necrosis, and non-union following intracapsular fracture of the neck of the femur. It was employed in several instances of fresh subcapital femoral fractures in very elderly patients who, it was felt, could not tolerate prolonged convalescence following nailing.

REFERENCES

1. GIBSON, ALEXANDER: Posterior Exposure of the Hip Joint. J. Bone and Joint Surg., **32-B**: 183–186, May 1950.
2. KOCHER, THEODOR: Chirurgische Operationslehre. Aufl. 5, S.442–444. Jena, Gustav Fischer, 1907.

MID-THIGH AMPUTATION IN A HEMOPHILIAC

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Operations which are undertaken without hesitation on a normal patient are performed on a hemophiliac only after careful consideration. The chances of the patient's survival without surgery must be balanced against the risks of surgery and of postoperative hemorrhage, which usually is fatal.

Craddock and his associates reviewed the literature in 1948 and found only eight reported cases of major surgery in proven hemophiliacs. Two of these were amputations; one of the thumb [2] and the other of an arm [3]—both successful.

The purpose of this communication is to report another successful amputation performed in a patient with hemophilia.

CASE REPORT

A white man, twenty-five years old, a known hemophiliac, was in reasonably good health until the day of admission, when his left leg was crushed between a motor and the wall while he was at work. He was admitted to Hamot Hospital shortly after the injury.

He had had many spontaneous hemorrhages in the past, including bleeding from the gums and nose, and three separate attacks of spontaneous hematuria during the previous five years, all of which had subsided without treatment. In 1943, while playing football, he sprained both knees. As the result of applying a heating pad to his knees he sustained a third-degree burn of the skin over the upper half of the left tibia, which required nine months to heal and left the knee and the ankle stiff in the same extremity which was later injured. The scar resulting from the burn was of the thickness of tissue paper and was covered by a dry, crusted exudate.

The family history revealed that his parents were living and well. One brother had died at the age of one year of hemophilia. There were no other siblings. One male cousin had also died of hemophilia at the age of twenty-six.

Physical examination revealed a well developed and well nourished white male. His skin was pale, warm, and moist. His pulse was eighty and regular, respirations were twenty, and blood pressure was 84 systolic and 52 diastolic. Temperature was 98.2 degrees. The upper portion of the left tibia was exposed for a distance of approximately six centimeters. The surrounding skin was adherent to the underlying tibia. There was considerable oozing from the wound, which contained a large blood clot. The dorsalis pedis pulse was palpable and was equal bilaterally. Other findings were entirely within normal limits.

The bleeding time on admission was one and one-half minutes. A Lee-White test for coagulation time was halted after thirty minutes with no clot retraction. The urine was normal.

X-ray examination of the left leg showed an undisplaced fracture of the proximal portion of the fibula and changes in the joint due to the patient's old injury. There were no joint changes attributable to hemophilia.

The patient was immediately placed in shock position with a massive pressure dressing applied to the wound. For the first ten days, vitamin-K injections and blood transfusions were administered. In spite of this there was continual oozing through the dressings. By the seventh day, the left foot, ankle, and the lower portion of the leg were oedematous and cold, and the left dorsalis pedis and posterior tibial pulses were no longer palpable.

By the tenth day there was definite evidence of gas gangrene in the left lower extremity and a blood culture revealed *Streptococcus hemolyticus* and *Clostridium sporogenes*. On the following day his temperature had risen to 103.5 degrees, his white blood count was 22,000 with 98 per cent. neutrophils, and his red blood count was 2,640,000.

A mid-thigh amputation of the left extremity was therefore carried out under general anaesthesia and with a high-thigh tourniquet. All tissue was severed by means of electrocautery. Vessels and nerves were cut perpendicularly and doubly ligated with No. 0 chromic catgut. The bone end was closed with bone wax. Just before skin closure, the tourniquet was removed; there was no oozing from the stump. Dry gelfoam was instilled in the wound, which was then closed with continuous and interrupted black silk, and covered with a large pressure dressing. The patient received two pints of whole blood while on the operating table.

Because of severe pain in the stump, the wound was dressed on the second postoperative day. There was

no bleeding but some drainage. A wound culture grew *Staphylococcus aureus* and a blood culture at the same time revealed *Clostridium sporogenes*. Various antibiotics were administered with no immediate improvement. His temperature rose to 105 degrees on the fourth postoperative day. However, by the eighth postoperative day, after he had received aqueous penicillin intramuscularly, and chloromycetin and terramycin by mouth, the wound drainage had begun to decrease and he was improving. Thereafter the infection was controlled, but on the eighth postoperative day, for the first time, bright red blood was seen oozing from the stump. The white blood count at this time was 12,000 and the red blood count 2,500,000. The patient was given intramuscular thromboplastin and blood transfusions. In spite of these measures the stump continued to ooze for the next ten or twelve days. Daily blood transfusions were being continued. In addition he received daily intramuscular injections of a hemostatic, consisting of an aqueous solution of oxalic and malonic acids with 0.25 per cent. phenol. By the twenty-first postoperative day the bleeding from the stump had ceased, but his condition became critical because of the development of gastro-intestinal hemorrhages. He vomited large amounts of blood, lapsed into shock, and became comatose. However, with oxygen and transfusions he improved and his bleeding stopped and thereafter ceased to be a problem. When the dressing was changed on about the thirty-first postoperative day the wound, for the first time, was found to be spread open throughout its entire extent. Over 1,000 cubic centimeters of a jelly-like clot was evacuated. All the silk sutures were removed, the skin edges were cleaned, the wound was packed with gauze and covered with a pressure dressing. There were no more hemorrhages, and on the forty-fourth postoperative day the daily injections of the oxalic and malonic acids were stopped. On the fifty-fourth postoperative day the patient was allowed up on crutches with no adverse effects. Three days later the patient was allowed to go home, walking on crutches. At that time the wound was open, but there was no drainage or bleeding. His white-cell count was 5,400 and his red-cell count was 3,840,000 with a hemoglobin of 67 per cent. During his hospital stay he had received a total of fifty-five units of whole blood.

FIG. 1

Condition of stump at time of discharge, January 1953.

For about six months, the patient has been seen in our Clinic once every two weeks. The stump has continued to heal, so that at the present time there is a granulating area of less than three square centimeters. This has oozed at times, but it has always stopped immediately after the application of silver nitrate. Since leaving the Hospital, the patient has been carrying on all of his normal activities, getting around on crutches. He uses the conventional type of crutch and has had no difficulty. Because of incomplete healing of the stump, no attempt has been made yet to fit him with a prosthesis.

REFERENCES

1. CRADDOCK, C. G., JR.; FENNINGER, L. D.; and SIMMONS, BRADFORD: Hemophilia, Problem of Surgical Intervention for Accompanying Diseases, Review of the Literature and Report of a Case. Ann. Surg., **128:** 888–903, 1948.
2. FIBOR, W. M., and WOODHALL, BARNES: Hemophilic Pseudo-Tumor: Diagnosis, Pathology, and Surgical Treatment of Hemophilic Lesions in Smaller Bones and Joints. Bull. Johns Hopkins Hosp., **59:** 237–250, 1936.
3. BLALOCK, ALFRED: Amputation of Arm of Patient with Hemophilia. J. Am. Med. Assn., **99:** 1777–1778, 1932.

DEEP INTERMUSCULAR LIPOMA OF AN EXTREMITY

A Case Report

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The case of a deep intermuscular lipoma of the forearm presented here is of interest because of the symptoms produced by the tumor, the roentgenographic appearance of the involved site, and the complete relief following excision.

The patient, J. S., was a woman forty-five years old, in good general health. Discomfort developed in her right forearm, radiating into the hand, six months before she sought medical attention in September 1950. She also complained of a grating sensation "in back of the elbow" on motion of the joint. The symptoms gradually increased in severity to the extent of interfering with her work as a sewing-machine operator and often disturbed her sleep. Use of the extremity aggravated the pain. She also complained of paraesthesia of the right hand, particularly of the fourth and fifth fingers.

Examination of the affected extremity demonstrated palpable grating along the posterolateral aspect of the upper part of the forearm and of the elbow when these parts were moved. There was hypo-aesthesia of the skin over the pathways of the ulnar nerve, associated with scattered areas of sensory median-nerve involvement. A consultant neurologist could not arrive at a definite diagnosis. Roentgenograms of the cervical spine were negative, but those of the forearm and elbow joint made on September 30, 1950, were very revealing. A sharply demarcated, multilocular, air-bubble-like area of radiotranslucency was readily discernible in the flexor compartment of the proximal third of the forearm in relation to the radius. Additional roentgenograms made on May 8, 1951 (Fig. 1), indicated an increase in the size of the radiotranslucent area. Slight fullness of the antecubital fossa was noted only after study of the roentgenograms.

In view of the progressive disability and increasing size of the lesion, operation was advised and was performed on June 9, 1951. The approach was made through a longitudinal incision along the anterolateral aspect of the right forearm, extending from the elbow distally. Dissection was carried through muscle planes to the anterior surface of the interosseous membrane. Here a yellowish, lobulated intermuscular mass, measuring six by six by four centimeters and having the consistency of lipomatous tissue, was exposed. The mass extended along the interosseous membrane to the neck of the radius, where it entered the posterior compartment of the forearm close to the elbow. The mass was adherent to the upper portion of the interosseous membrane, from which it was separated by sharp dissection. The remainder of the tumor was well encapsulated and was shelled out easily. Figure 2 shows two pieces of the gross specimen which was excised. A branch of the anterior interosseous nerve was intimately related to the growth.

FIG. 1-A FIG. 1-B

Roentgenograms of the right forearm taken before operation, showing the translucent soft-tissue area below the elbow joint.

Microscopic sections showed the mass to be a simple lipoma (Fig. 3).

The patient made an uneventful recovery from the operation. She was completely relieved of her symptoms and was able to return to work as a sewing-machine operator three weeks after surgery.

Follow-up examination, including roentgenograms, on April 30, 1952, showed no recurrence of the mass, nor was there recurrence of the symptoms.

FIG. 2

Photograph of the mass (actual size) removed at operation.

COMMENT

Deep lipomata can occur in almost any anatomical location. The authors' study, however, was confined to those associated with the musculoskeletal system. The subject is extensively covered in the literature, listed under numerous headings,—such as "subfascial", "subaponeurotic ', "deep, intermuscular", "submuscular", "subsynovial", "subserous", and "periosteal" lipomata. Several comprehensive articles and reviews are available; 102 cases were reported by Plettner in 1889, 149 cases by Dertinger in 1903, twenty-four cases by Dege in 1906 (in all of these cases the tumor was intramuscular), and 189

FIG. 3

Microscopic section (×90) indicating the lipomatous character of the tumor.

cases by Behrend in 1929. Only a few articles have appeared in the last decade. Cruveilhier and Paget collected specimens of the growth as a hobby, according to Behrend.

It would seem from the above citations that deep lipomata should be encountered more frequently, but Behrend reported only one case in twenty-five years at the Daniel Baugh Institute of Anatomy at Jefferson Medical School, during which period more than 2,500 bodies were dissected.

Deep lipomata are benign, slowly growing, and encapsulated; and they are shelled out easily. On occasion the size and location may render removal difficult. Two instances of diffuse growth of the lipoma with apparent invasion of the involved muscle have been recorded [7]. In one of these instances there was a recurrence. Other recurrences have not been recorded, although they can take place if the tumor, with all its lobulations, is not completely removed. Occasionally the tumor produces symptoms either because of its size or because of pressure on adjacent nerve trunks. A most interesting case was reported recently by Richmond in which the tumor caused a paralysis of the posterior interosseous nerve. The diagnosis is difficult clinically, and the mass can be confused with fibroma, cyst, hemangioma, abscess, muscle herniation, and other soft-tissue masses. Roentgenographically the diagnosis is often obvious, as in our case. The lobulated, sharply demarcated, radiotranslucent area is distinctive and, according to Samuel, almost pathognomonic. Among others, Mackenzie, Kraybill, Coventry and Ghormley, Templeton, and Hunt and Bisgard have emphasized this point. The latter were able to diagnose six of seven deep lipomata roentgenographically, whereas clinically there was considerable doubt as to the diagnosis. Much discussion of etiological factors is included in the literature.

In Cases 74 through 80 listed by Dertinger the tumor originated at the elbow and upper forearm, anatomically approximating the case presented by us in this article. In Case 78 the tumor apparently had its origin in the interosseous membrane near the elbow and grew to either side of the membrane, as in our case. Mackenzie's case and especially that of Kraybill followed the same pattern. In the latter case, a second and posterior incision was required for removal of the tumor. In our case it was possible to remove the tumor through one incision by delivering the posterior portion of the tumor into the anterior compartment of the forearm.

REFERENCES

1. Behrend, Moses: Intermuscular Lipomas. Report of Three Cases. Am. J. Surg., **7**: 857–860, 1929.
2. Coventry, M. B., and Ghormley, R. K.: Lipoma of the Thigh. Report of a Case. Proc. Staff Meet. Mayo Clinic, **16**: 697–699, 1941.
3. Dege: Ueber intramusculäre Lipome der Extremitäten. Deutsche Mil. Ärztl. Ztschr., **35**: 565–579, 1906.
4. Dertinger, Karl: Ueber tiefsitzende Lipome. Beitr. z. Klin. Chir., **38**: 76–115, 1903.
5. Hunt, H. B., and Bisgard, J. D.: The Roentgenographic Diagnosis of Lipoma. Surg., Gynec., and Obstet., **71**: 68–71, 1940.
6. Kraybill, W. G.: Deep Lipoma. A Case Report. Nebraska S. Med. J., **29**: 146–147, 1944.
7. Kuttner, H., and Landois, F.: Die Chirurgie der Quergestreiften Musculatur. Deutsche Chir., Lfg. **25a**: 228–235, 1913.
8. Mackenzie, Kenneth: Parosteal Lipoma. New Zealand Med. J., **39**: 207, 1940.
9. Plettner, Adolph: Beitrag zur Kenntniss der Tiefgelegenen (Subfascialen) Lipome. Inaugural-Dissertation. Leipzig, Breitkopf & Härtel, 1889.
10. Richmond, D. A.: Lipoma Causing a Posterior Interosseous Nerve Lesion. J. Bone and Joint Surg., **35-B**: 83, Feb., 1953.
11. Samuel, Eric: The Radiological Diagnosis of Lipomata. British J. Radiol., **20**: 55–57, 1947.
12. Templeton, F. E.: Roentgen Diagnosis of Lipomata. Am. J. Roentgen., **37**: 210–216, 1937.

LEGG-PERTHES DISEASE IN TWINS *

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The literature has been reviewed in an attempt to find reports on the familial diathesis of Legg-Perthes disease and particularly on its occurrence in monozygotic twins. Lindemann was quoted as having reported bilateral occurrence of Legg-Perthes disease once in enzygotic and once in dizygotic twins [6]. However, upon review of the original article the report was found to be on changes in the femoral head in association with bilateral coxa vara[5]. The development of Legg-Perthes disease in several members of a family has been reported by Cavanaugh, Shelton, and Sutherland. These authors felt that the condition was due to hypothyroidism. Hagen reported bilateral coxa plana occurring in two

FIG. 1-A

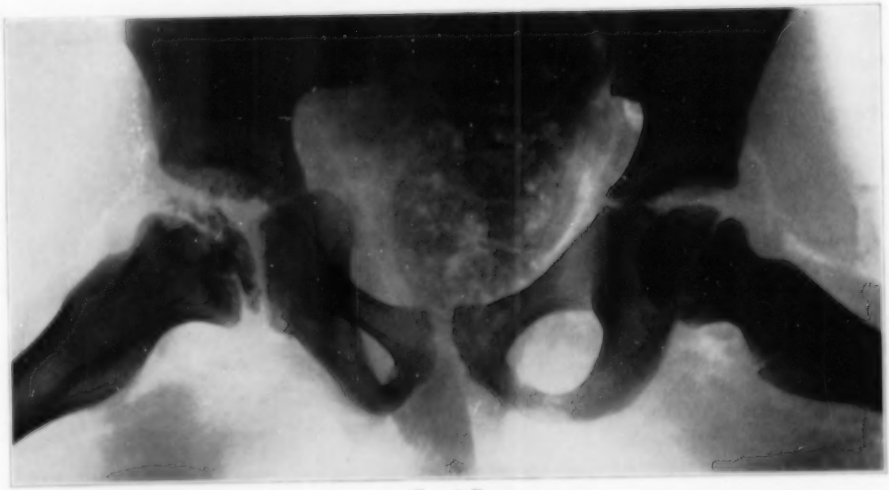

FIG. 1-B

Typical coxa plana of the right hip in Donald, a male twin, nine years old.

* Read at the meeting of the Tri-State Orthopaedic Association, Homestead, Virginia, April 1952.

brothers. Stephens and Kerby, in 1946, presented a very careful study of the occurrence of this condition in twenty-eight members of a family during five generations. They concluded that it was inherited as a simple dominant trait, variable in type. McComas reported the occurrence of four cases of Legg-Perthes disease in a family in which a father and his sister presented bilateral involvement, while his brother and one son had unilateral involvement. His other children presented normal hips. Resnick reported a punctate epiphyseal dysplasia with coxa plana occurring in identical male twins and in their mother. However, they demonstrated this epiphyseal dysplasia in other bone structures as well. No reports were found of true Legg-Perthes disease occurring in twins, without other stigmata of diffuse epiphysitis. An article by Turpin, Tisserand, and Sans presented the occurrence of chondro-epiphysitis in twins. They found this condition in seven monozygotic twins, but the involvement was of the tarsal scaphoid or of the patellar nucleus. In their study of five cases of dizygotic twins, the epiphysitis was not identical but, here again, no involvement of the capital femoral epiphysis was reported in either the monozygotic or the dizygotic twins.

This case report presents two interesting factors: the occurrence of Legg-Perthes disease in identical male twins, and the concomitant presence of coxa plana in a younger sister.

A roentgenographic study of the entire family, including the father, the mother, and the five other siblings, revealed no involvement of any of the epiphyses. Careful questioning of the parents about the presence of any hip disease or hip instability in the aunts, uncles, grandparents, and great-grandparents of these children did not elicit any additional evidence of coxa plana.

The nine-year-old male twins were seen on January 11, 1951. Donald gave a history of limping for nine months. Roentgenograms were made which demonstrated the presence of Legg-Perthes disease of the right hip (Figs. 1-A and 1-B). Laboratory findings were entirely negative. The sedimentation rate was normal and all blood components were within normal limits. The basal metabolic rate was +15. Examination of the right hip at this time revealed 50 per cent. limitation of motion in abduction but full range of motion in flexion, extension, and adduction. There was pain upon extremes of motion. There were no other abnormalities.

The other twin, Ronald, was seen at the same time. Approximately thirteen months previously, this child had been observed by his parents to be limping on both lower extremities for no apparent reason.

FIG. 2

Changes indicative of coxa plana in the left hip of Ronald, a male twin nine years old.

FIG. 3-A

FIG. 3-B

FIG. 3-C

Figs. 3-A and 3-B: Advanced changes of the head of the right femur in the younger sister, Dolores Ann, five years old.

Fig. 3-C: Irregular ossification of the tarsal navicular in both feet of the sister, Dolores Ann.

The limp continued for three months and then disappeared spontaneously. However, he continued to complain of "aches and pains" in his left hip during the rest of the year. Examination revealed a well developed, well nourished child who walked with no limp in either lower extremity. The lower extremities were of equal length. All hip motions were normal and painless except that upon internal and external rotation, there was some discomfort and some muscle spasticity bilaterally. Roentgenographic study revealed Legg-Perthes disease of the left femoral head (Fig. 2). Laboratory findings were within normal limits.

Dolores Ann, five years old, was seen on the same date. She complained of pain in her right hip, which had developed only six days previously after a fall. Her history revealed that she had fallen one year before and had then limped for a period of approximately six weeks. Her limp then cleared up spontaneously. Examination revealed a full range of painless motion of the right hip. There was no evidence of any shortening of the right lower extremity, no atrophy of the right thigh, and no spasm of the muscles about the right hip. All laboratory findings were within normal limits. Roentgenograms revealed advanced Legg-Perthes disease of the head of the right femur (Figs. 3-A and 3-B).

A roentgenographic survey of the skeleton was performed on all three children, and the only finding of interest was the presence of an irregular ossification of the tarsal navicular bilaterally in the younger sister (Fig. 3-C).

Treatment of these three children has consisted of immobilization of the involved extremity in a hip spica. Successive roentgenograms demonstrated the changes usually seen during the healing of coxa plana. Recent roentgenograms show almost complete healing of the involved capital epiphyses and, in the sister, progressive confluence of the separate ossification centers of the tarsal navicular bones.

REFERENCES

1. Cavanaugh, L. A.; Shelton, E. K.; and Sutherland, Ross: Metabolic Studies in Osteochondritis of the Capital Femoral Epiphysis. J. Bone and Joint Surg., **18**: 957–968, Oct. 1936.
2. Hagen, W. H.: Coxa Plana: Report of Two Bilateral Cases in Brothers. J. Bone and Joint Surg., **21**: 1028–1030, Oct. 1939.
3. Lindemann, Karl: Das erbliche Vorkommen der angeborenen Coxa Vara. Zeitschr. f. Orthop., **72**: 326, 1941.
4. McComas, Elizabeth: Perthes's Disease and Its Occurrence as a Familial Condition. Med. J. of Australia, **2**: 584–585, 1946.
5. Resnick, Eber: Epiphyseal Dysplasia Punctata in a Mother and Identical Male Twins. J. Bone and Joint Surg., **25**: 461–468, April 1943.
6. Schinz, H. R.; Baensch, W. E.; Friedl, E.; and Uehlinger, E.: Roentgen Diagnostics. First American Edition, James T. Case, Editor. Vol. I, p. 740. New York, Grune & Stratton, 1951.
7. Stephens, F. E., and Kerby, J. P.: Hereditary Legg-Calvé-Perthes' Disease. J. of Heredity, **37**: 153–160, 1946.
8. Turpin, R.; Tisserand, M.; et Sans, R.: Les chondro-épiphysites des jumeaux. Rev. Française de Pédiatrie, **15**: 492–499, 1939.

A SIMPLE TECHNIQUE FOR X-RAY MEASUREMENT OF LIMB-LENGTH DISCREPANCIES

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Since the publication of papers by Blount, Green, White, Phemister, and others on equalization of limb lengths by epiphyseal arrest, tremendous interest in this orthopaedic problem has developed. The technical difficulties encountered in the proper evaluation of these patients are in the accurate measurement of the true difference in the length of the lower extremities, and the determination of the segment or segments of the extremity in which the discrepancy occurs.

There have been several methods described for the measurement of limb length, and several devices have been manufactured for this purpose. In our opinion, all of the methods and devices suggested are either too complicated or too expensive to be practical for general office or hospital use. The method described here is similar to that used and described by White[1]. We feel that White's technique is subject to some error on the part of the patient in the exertion of equal foot pressure bilaterally and on the part of the orthopaedist in measurement of the films.

We wish to describe a method of limb-length measurement which is simple, accurate, and requires a minimum of equipment. The equipment consists of any standard x-ray table with a Bucky grid, one sheet of lead-filled rubber one-sixteenth inch in thickness, and a few blocks of plywood, three inches wide by six inches long and of known thickness.

The sheet of lead-filled rubber must accurately cover a cassette fourteen by seventeen inches. This sheet is then cut into three strips—one eight inches wide and the other two

strips each four and one-half inches wide. The patient is centered on the x-ray table. The head of the table must be elevated approximately 20 to 25 degrees (Fig. 1) so that body weight will press the patient's feet against the foot rest. It is essential to be sure that both feet are exerting the same amount of pressure on the foot rest. This can best be done if the patient first places himself on the table, with knees flexed and feet against the foot board, and then pushes his body upward on the table, extending his limbs.

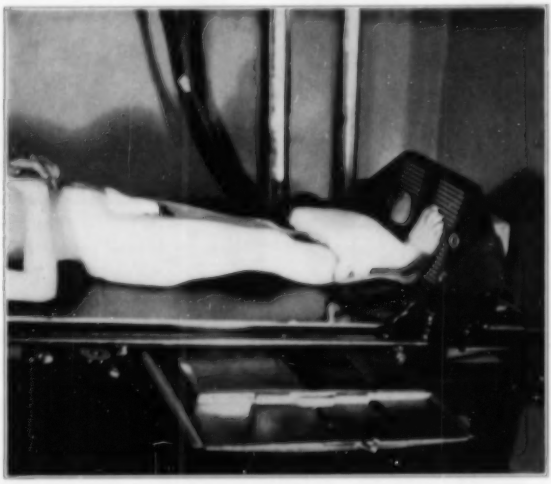

FIG. 1

Photograph of patient on the x-ray table, showing how the feet exert equal pressure against the foot rest. The cassette is shown with the lead-filled rubber masking strips placed for an anteroposterior exposure of the knee joints.

In many instances, both feet cannot be placed against the foot rest with the limbs extended, because of excessive discrepancies in limb length or deformities of the feet. This difficulty can be eliminated by placing a sufficient number of plywood boards of known thickness beneath the foot on the short side, thus enabling both feet to exert the same amount of pressure, one against the foot rest and the other against its plywood supplement. A small sandbag is then placed across the middle of the legs to prevent motion. A marker showing the total thickness of the plywood boards is placed on the cassette for later reference.

A cassette, fourteen by seventeen inches, is placed in the Bucky tray and pressed firmly against the bottom edge. It is important that the cassette be square with the table to ensure accurate measurements. The eight-inch strip and one of the narrower strips of lead-filled rubber are placed over the upper part of the cassette to mask it. The cassette, Bucky tray, and tube are then centered at the ankles. The tube must be at a true right angle to the cassette and at least thirty inches away, to minimize distortion. An anteroposterior exposure is then made of the ankle joints. The cassette carriage is then moved and centered under the knees with the four-and-one-half inch strip of lead-filled rubber moved down to cover the exposed lower portion of the film. In moving the tray and lead-filled rubber strips, care must be taken not to disturb the cassette in the tray. An anteroposterior exposure is then made of the knees, and then the two smaller lead-filled rubber strips are placed over the lower portion of the cassette and the large one is removed. The cassette and tube are then centered at the hips and an anteroposterior exposure of the hips is made. The film is now ready for developing.

When the film is dry, it is placed on a view box and is measured in the following manner: Horizontal lines are drawn perpendicular to the sides of the film through identical points in the ankles, knees, and hip joints (or in the pelvis in any case of hip-joint disease with destruction of the head of the femur or of the acetabulum) (Fig. 2).

The vertical distance between the lines drawn through the ankle joints represents the difference in height of the feet. This point is neglected in most other measurements of limb-length discrepancy, but the authors feel that this is important as there may be a difference of one to two centimeters in height in some paralytic, deformed, or fused feet. The distance between the lines drawn through the hip joints represents the total difference in length of the two extremities. If plywood blocks have been placed under one foot, the height of these is added to the total length difference.

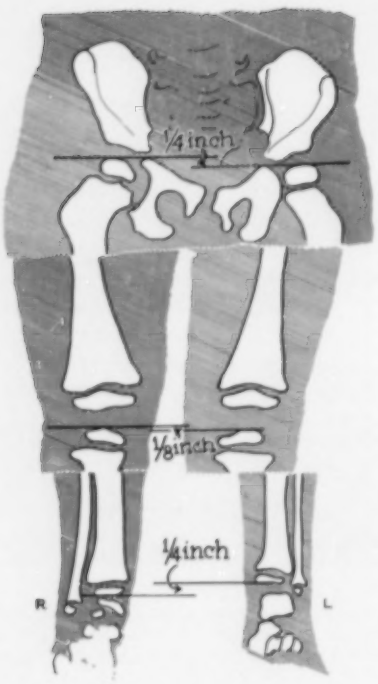

FIG. 2

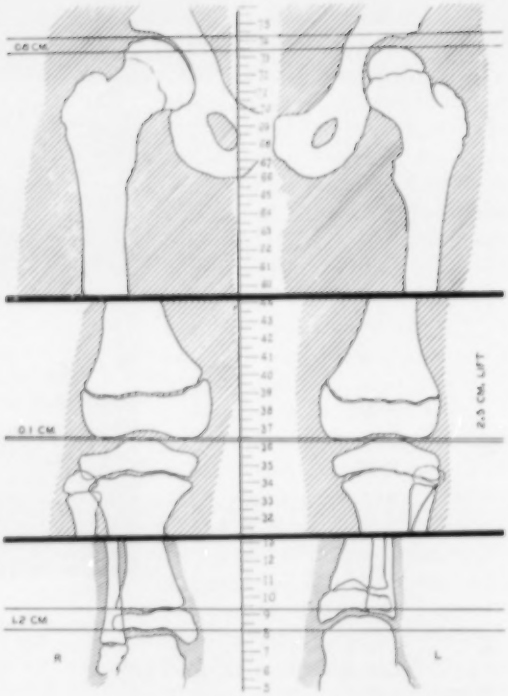

FIG. 3

Fig. 2: Artist's reproduction of an x-ray, showing method of measuring limb-length discrepancies directly from x-ray film.

Fig. 3: Artist's reproduction of an x-ray, showing the method of measuring limb-length discrepancies from a film on which a calibrated ruler was placed. Note the marker on the left side denoting the use of a 2.5-centimeter lift beneath the left foot. This measurement is added to the total length deficiency on the short side.

The measurements on a metal ruler placed in the center of the x-ray table will be reproduced in the developed film. It is essential to fix the ruler lengthwise on the exterior center of the table with adhesive strips at either end to keep it stationary. Accurate limb-length measurements can then be made directly from the ruler (Fig. 3).

This method has two advantages. It enables the height of the feet to be measured accurately, and it also enables identical points in the pelvis to be used in total length measurement, which is necessary where there has been destruction of the hip joint itself.

We have used this method of limb-length measurement for the past two years at the Crippled Children's Hospital in Richmond, Virginia, and more recently at the Medical College of Virginia Hospital with very satisfactory results.

1. WHITE, J. W.: A Practical Graphic Method of Recording Leg Length Discrepancies. Southern Med. J., **33:** 946–949, 1940.

BLADE PLATE FOR EXTENSION OSTEOTOMY OF THE FEMUR

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From the Second Orthopaedic Service, Hospital for Joint Diseases, New York

As in all solutions of osseous continuity, the chief technical difficulty encountered in the use of the subtrochanteric osteotomy has been the maintenance of the desired positions of the osteotomized fragments of bone. With Blount's modification [1] of the Moore blade plate, a method for the overcoming of this difficulty was developed, and, in consequence, the immobilizing plaster-of-Paris spica, together with a host of specialized retentive operative procedures, became practically obsolete. While the Blount-Moore blade plate is ideal for use in the angulation osteotomy in the coronal plane, it has not been easily adapted for use in osteotomy in the sagittal plane.

In order to overcome this difficulty, a special type of blade plate has been devised (Figs. 1-A to 1-C). The blade portion is about 3.8 centimeters in length and is so curved

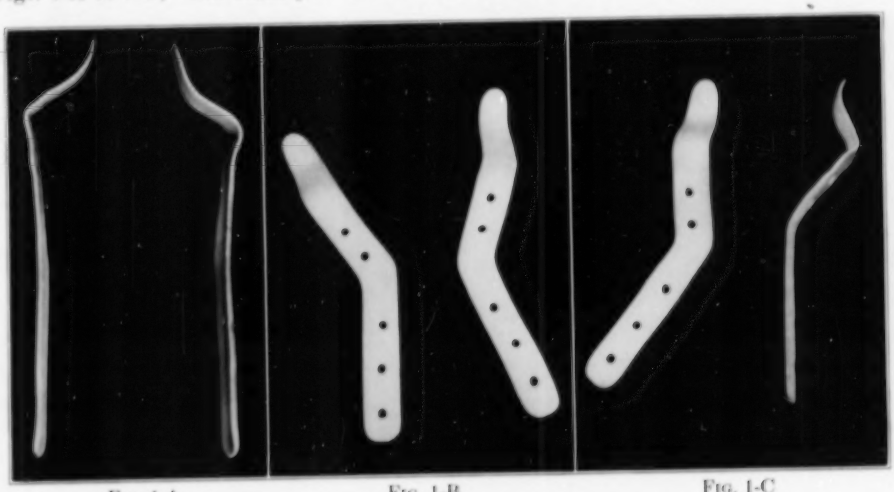

FIG. 1-A FIG. 1-B FIG. 1-C

Fig. 1-A: Side view of the blade plate for the right hip and that for the left hip.
Fig. 1-B: Front view of the blade plate for the right hip and that for the left hip.
Fig. 1-C: Front and side views of blade plate permitting angulation in the sagittal plane as well as in the coronal plane, that is, extension and abduction.

as to obtain a firm grip in the region of the trochanter without it being necessary for the surgeon to insert the blade axially into the femoral neck. The plate, or lower portion, consists of two parts—an upper straight portion about 3.8 centimeters long, and a lower part of any desired length which is angulated on the flat to correspond with the angle which the distal fragment of the femur makes with the portion of the shaft proximal to the osteotomy.

The blade plate is cut from 17-gauge 8Mo steel and must be made for each patient to meet the requirements of the individual case. Although the lower portion of the plate usually lies in the same plane as the upper 3.8 centimeters, it may be angulated outwardly to combine abduction with the extension type of osteotomy (Fig. 1-C).

The backward angulation of these plates cannot be altered at the operating table; and it is, therefore, essential to determine exactly the degree to which it is desired to extend the distal portion of the osteotomized femur. The accurate measurement of the angle of flexion deformity is, of course, an absolute prerequisite for this determination.

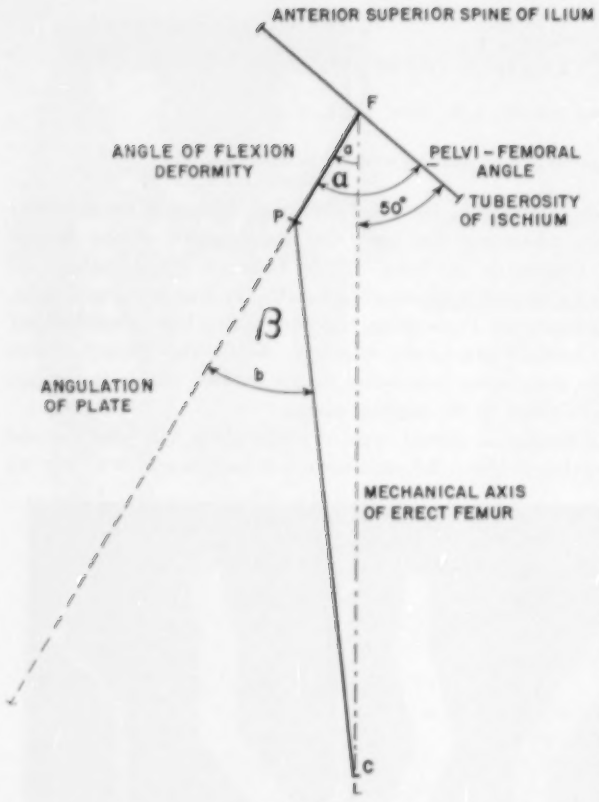

FIG. 2

The degree to which the blade plate must be angulated to correct a flexion deformity at the hip is shown. Angle a equals the pelvifemoral angle minus 50 degrees, P is the point at which osteotomy is performed, β is the angle of backward angulation of the plate. Since angle β equals angle a plus angle C, angle β must be greater than angle a by the value of angle C. By the law of the sines,

$$\sin C = \frac{PF}{PC} \sin a.$$

Even in the consulting room, where the limitations of asepsis offer no hindrance, the clinical test usually employed for the determination of the presence of a flexion deformity has been found to be neither accurate nor objective.

In patients in whom ankylosis of the lumbosacral joint and of the contralateral hip has co-existed, the degree of fixed-flexion deformity can frequently only be estimated. In patients in whom one hip alone is involved, the results from consecutive examinations by a group of adequately trained observers, or by the same observer at several times, have varied to such a degree as to indicate that such examinations are totally without value.

The inaccuracy of such determinations of the degree of fixed flexion of the hip can be avoided by the use of a previously described pelvifemoral angle [2]. As a result, in an uncounted number of examinations on patients of all ages and of both sexes, it has been found that, at its maximum extension, the thigh makes with Nélaton's line a backward and outward opening angle of about 50 degrees. Even in obese patients, the ischial tuberosity can easily be palpated in the gluteal fold and the position of Nélaton's line touching the tip of the trochanter can readily be determined. By the use of this angle, it is possible to measure the flexion of the femur on the pelvis to within 5 degrees. In patients in whom there is combined flexion deformity of the trunk and the hip, the degree due to each can be differentiated by the combining of the pelvifemoral angle with a determination of the acromiofemoral angle [4]. The degree to which the measured pelvifemoral angle exceeds the normal value of 50 degrees is a clinically accurate and objective measurement of the flexion deformity at the hip.

Since osteotomy to correct flexion deformity is usually performed in the subtrochanteric region at some distance below the hip joint, it is obvious that the angulation of the distal fragment will have to be slightly greater than the measured degree of fixed flexion. This can readily be seen in Figure 2 which is a schematic representation of a lateral view of the femur fixed in a degrees of flexion. Were osteotomy performed at the hip joint (F), extension of the distal fragment through a degrees would serve to correct the flexion deformity. If, on the other hand, the osteotomy is performed in the subtrochanteric region (P), it is obvious that the angle β through which the distal fragment

must be extended is of necessity larger than angle α. Since angle β is, in fact, the supplement of the interior angle at P, it is exactly equal to the sum of the other angles $(F + C)$. Therefore, angle β exceeds angle α by the amount of angle C.

This value can be readily established by the law of the sines described in elementary trigonometry. Essentially, the problem is that of the determination of an angle in a triangle of which two sides and an adjacent angle are given. These are:

1. The pelvifemoral angle;
2. The length of the femur from the tip of the trochanter to the condyle PC;
3. The level of the osteotomy (that is, the length of the proximal fragment from the tip of the trochanter to the osteotomy site) PF.

The solution of this problem and its application to the extension osteotomy can perhaps best be illustrated by an actual example in a patient who presented a pelvifemoral angle of 70 degrees (that is, a flexion deformity of 70 minus 50 degrees, or 20 degrees), whose thigh measured 40 centimeters, and in whom it was proposed to do an osteotomy at a point 7.5 centimeters below the tip of the trochanter. If we substitute for these the values in the previously described formula, it is clear that

$$\sin C = 3/13 \sin \alpha$$
$$= 3/13 \times 0.3420 = 0.07939$$
$$\text{whence } C = 4.5 \text{ degrees}$$
$$\text{and } \beta = 20 \text{ degrees} + 4.5 \text{ degrees} = \text{ca. } 25 \text{ degrees.}$$

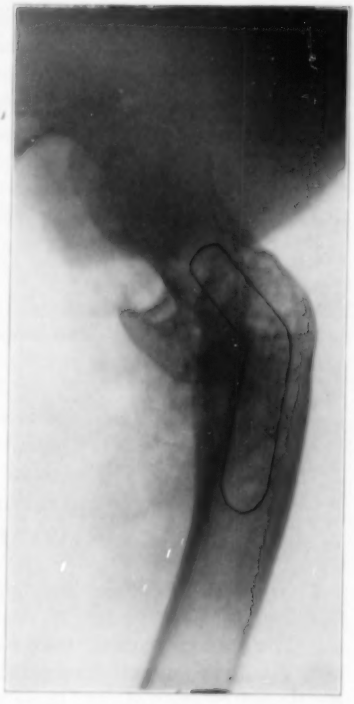

FIG. 3

Roentgenogram of the right femur after extension osteotomy, in which the position of the plate previously removed is shown in ink.

As a matter of expediency, the amount by which the angulation of the nail must be greater than the measured angle of fixed-flexion deformity (that is, the value of angle C) may be gauged in an approximate manner. The length of the proximal fragment divided by the length of the longer distal fragment yields a fraction. Angle C is approximately equal to this fractional value of the angle of hip flexion. In the illustration given previously, this ratio would be 3/13 or ¼. The value of angle C is, therefore, approximately ¼ of the value of 20 degrees, or 5 degrees. Thus, if the backward angulation of the nail is increased by this amount, the upper and lower ends of the femur will be brought into alignment; the flexion deformity will be corrected in the same way as if the osteotomy had been performed at the hip joint.

When it is desired to correct an adduction deformity or to afford pelvic support, the lower portion of the bent plate can be abducted at the apex of the extension angle. The amount to which angulation is permissible will be determined by the inclination of the pelvic wall. Usually this inclination determines a critical value for the postosteotomy angle [3] beyond which the blade should not be angulated outward.

This extension type of plate has been employed in the treatment of fixed-flexion deformities due to (1) flexion at the hip and (2) flexion at the lumbosacral joint. In both instances the principle of treatment had been suggested by the patient's use of crutches when he was in the erect position. The patient walked with his crutches behind the flexed thigh and in line with the body. It is apparent that the patient's center of gravity lay

behind the support afforded by his feet, and that the posterior footing of the crutches was such as to supply the necessary equilibrium. This is precisely the purpose of the extension osteotomy—to bring the feet backward under the center of gravity (Fig. 3). The proper use of the plate herein described will permit the accurate correction of fixed-flexion deformity without the necessity of immobilizing the patient in plaster.

REFERENCES

1. Blount, W. P.: Blade Plate Internal Fixation for High Femoral Osteotomies. J. Bone and Joint Surg., **25**: 319–339, Apr. 1943.
2. Milch, Henry: The Pelvifemoral Angle. Determination of Hip-Flexion Deformity. J. Bone and Joint Surg., **24**: 148–153, Jan. 1942.
3. Milch, Henry: The Postosteotomy Angle. J. Bone and Joint Surg., **26**: 394–400, Apr. 1944.
4. Milch, Henry: The Acromio-Femoral Angle. Bull. Hosp. Joint Dis., **8**: 150–154, 1947.

PROCEDURE FOR CUTTING THE STEM OF A VITALLIUM HIP PROSTHESIS

BY HENRY H. KESSLER, M.D., AND HERBERT M. SIMONSON, M.D., NEWARK, NEW JERSEY

The authors recently were faced with the problem of shortening the protruding stem of a Vitallium femoral-head prosthesis. A very tender area over the end of the stem had developed in one patient; there was also considerable pain on attempting to ambulate. She could not lie on the affected side and sleep was greatly disrupted (Fig. 1).

The authors learned that in previous attempts to cut such a Vitallium stem great difficulty had arisen. An ordinary revolving saw-blade was inadequate for cutting Vitallium. In one instance, multiple drill holes had been made across the stem by the use of a diamond-tipped dentist's drill; then a saw had been used to complete the severance. The procedure took approximately three hours.

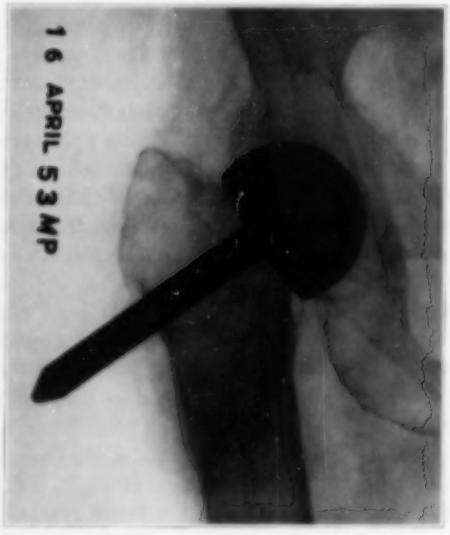

Fig. 1
Preoperative x-ray showing the protruding stem.

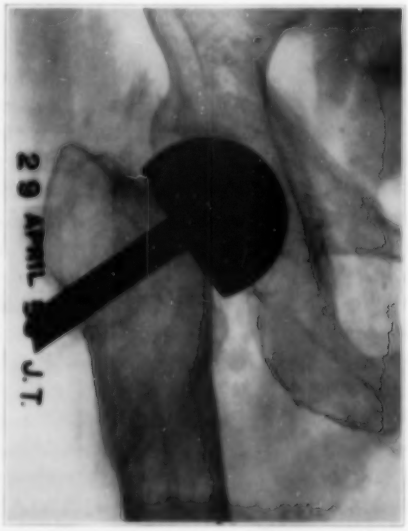

Fig. 2
X-ray made after the operation

In another case the stem had been "bitten" off with a pair of heavy-duty wire-cutters. This required a powerful operator and an unwieldy instrument with a high mechanical advantage. Both methods left the end of the shortened stem irregular, so that it might possibly contribute to continued irritation and pain.

The problem, then, was to devise a method whereby the Vitallium stem could be cut off smoothly, quickly, and without danger to patient or surgeon. Through the interest and cooperation of the Austenal Laboratories it was possible to secure a thin metal disk with an abrasive band of diamond dust around the edge. This disk was approximately one and one-half inches in diameter, with a hole in the center in which a small notch had been made so that it could be fitted onto the same stem of the Luck saw to which the oscillating type of blade is ordinarily attached (Fig. 3). With this diamond-dust banded disk and the Luck saw, the protruding stem of a Vitallium prosthesis was easily severed in approximately one minute. The patient made an uneventful recovery from this operation, and the pain and discomfort were greatly relieved.

The important points in this procedure are as follows:

1. The disk must be sterilized by boiling only. A satisfactory method is to suspend it on a thin wire in boiling water. It can then be removed by grasping it with a sterile hemostat and cutting the wire with sterile scissors. If the disk lies flat in the pan during boiling, the heat to which it is subjected may become excessive and injure the abrasive band, or the edge may be injured in the attempt to lift it from the pan so that it may be grasped by forceps or hemostat. According to the manufacturer's directions, any other method of sterilization, such as autoclaving or the use of bactericidal solutions, may loosen the diamond dust and thereby make the disk ineffective.

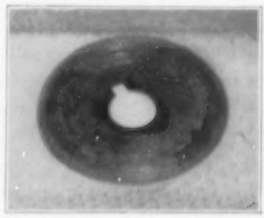

FIG. 3

The diamond-banded abrasive disk, devised for cutting Vitallium.

2. The affected hip should be elevated on a sandbag in order to provide sufficient room in which to operate.

3. Exposure of the protruding stem must be sufficient to provide a safe margin between surrounding soft tissues and the cutting process. This necessitates adequate assistance and the use of a large self-retaining retractor. The wound may be walled off with laparotomy pads in order to protect the soft tissues still further and to keep Vitallium dust from spreading over the wound.

4. It is essential that the Luck saw be grasped firmly with both hands, and that the surgeon's forearms be stabilized by supporting them on a small table.

5. When the exposure has been made sufficient for the introduction of the disk into the wound, the cutting process may be started. A stream of cool water is directed over the abrasive disk and the Vitallium stem throughout the procedure. The saw is permitted to rotate (not oscillate) at maximum speed and is then gently and smoothly applied to the stem so that it does not bounce against it. It is allowed to cut its way across the stem at its own pace; only as much forward pressure should be exerted on it as is required to maintain its progression. If it is necessary to interrupt the process before the stem is completely severed, the motor should be kept rotating at maximum speed while the disk is being withdrawn from the stem.

6. The severed end of the stem will simply drop off when it is completely cut through. There is no danger of its flying off and possibly inflicting injury. The cut edge of the stem should be perfectly smooth at the completion of the procedure, but any significant roughness or irregularity can be smoothed off by applying the rotating disk at right angles to the surface of the stem.

7. Most of the Vitallium dust which may have accumulated in the wound can be removed by irrigation.

HOMOLOGOUS-SERUM HEPATITIS FOLLOWING THE USE OF REFRIGERATED BONE-BANK BONE

Report of a Case

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Perusal of the literature fails to reveal any published instances of homologous-serum hepatitis produced in the recipient of refrigerated bank bone obtained from a donor carrying the offending virus. That such a mode of transmission is possible is obvious from current information regarding homologous-serum hepatitis and its causative virus.

Virus hepatitis is divided into two forms: (1) infectious hepatitis, which refers only to those cases that occur either sporadically or epidemically without any known means of inoculation; (2) homologous-serum hepatitis, which designates that form of the disease resulting from the parenteral inoculation of human blood or its products containing the virus. It is obvious, of course, that either of the two forms may be caused by either of the two known strains of virus which can cause hepatitis in man [3].

Investigations carried on during World War II have indicated the viral etiology of hepatitis. The virus is infectious only to man and consequently cannot be studied by transmission through the laboratory animals. The information obtained to date has been obtained essentially from studies in volunteers. The first report was made by Oliphant and his associates in 1943. They studied volunteers who were affected with homologous-serum hepatitis after parenteral inoculation of serum from patients in the acute phase of the disease resulting from the administration of known icterogenic yellow-fever vaccine. Findlay and MacCallum were the first to describe the relationship between outbreaks of jaundice and the preceding mass inoculation against yellow fever. In 1942, United States Army records revealed 51,337 cases of homologous-serum hepatitis following the administration of yellow-fever vaccine [6]. It has been shown [3] that the virus will pass through a Berkefeld filter and that it is resistant to temperatures of 56 to 60 degrees centigrade for at least thirty minutes. The virus has been shown [3] to survive temperatures of −10 to −20 degrees centigrade for four and one-half years, but to become inactive after five years at this temperature. The virus also survived in serum containing merthiolate in a concentration of 1 to 2000 [3]. It has been shown that the disease can be transmitted by as little as 1 per cent. of one cubic centimeter of blood or blood product containing the virus [4]. Hence it is obvious from the established information regarding the virus that an untreated piece of bone from a donor harboring the virus could cause the disease in the recipient.

Case History of Patient

The case at hand is that of a senior student in the Yale University School of Medicine who sustained a depressed fracture of the lateral tibial plateau. Attempts to obtain a satisfactory reduction by closed methods failed and an open reduction was done. Upon exposure of the joint surface, it was found that a column of the tibial plateau containing an appreciable portion of the articular surface of the lateral condyle had been depressed about two centimeters below the joint surface. In order to avoid further disruption of the articular surface, a hole was made in the tibia at the level where the shaft flares into the proximal metaphysis and the detached fragment was loosened from below and elevated until the continuity of the articular surface had been restored. The elevated column was then reinforced by packing beneath it cancellous bone obtained from the bone bank.

The postoperative course was uneventful. The patient received no antibiotics, no transfusions of blood or blood products. The only possible occasions of entry of the virus were the acupunctures for the preoperative and postoperative blood counts and the venipuncture for administering sodium pentothal anaesthesia.

The bone had been taken from the proximal metaphysis of a tibia obtained from an above-the-knee amputation in a male, seventy-three years old, who suffered from obliterative peripheral vascular disease.

Case History of Donor

The donor had been in the New Haven Hospital on two previous occasions. He was admitted initially in 1941 with a suspected aneurysm of the left subclavian artery, but studies at that time failed to corroborate this impression. No information obtained from the clinical record indicated any history of jaundice or liver disease.

The donor was next admitted in 1949 because of symptoms referable to his obliterative peripheral vascular disease, and a left lumbar sympathectomy was done. The patient received a blood transfusion during this procedure. Studies at that time failed to reveal any past medical history indicating jaundice or other hepatic disease. Liver-function tests consisting of a serum-bilirubin determination, thymol-turbidity determination, cephalin-cholesterol flocculation determination, and serum-alkaline-phosphatase level were all within normal limits.

The donor's final admission to the Hospital occurred five months prior to the use of the bone in the recipient site, and two and one-half years following the previous admission in 1949, during which the sympathectomy had been performed and at which time the patient had received the blood transfusion. The history again failed to reveal any evidence of occurrence of jaundice or liver disease during this period. Liver-function tests on this admission were again within normal limits.

The patient had an above-the-knee amputation. The bone obtained was immediately cut into small portions under aseptic conditions, put into double sterile containers, and stored in the deep freezer. The donor's postoperative course was uneventful for two weeks, when he suddealy experienced difficulty in breathing, after which he went into collapse and died, presumably from pulmonary embolism. Permission for a postmortem examination was not obtained.

In so far as the recipient of the bone is concerned, his postoperative course was uneventful for ten weeks, at which time hepatitis with jaundice developed, the prodromal symptoms and clinical picture of which were consistent with a diagnosis of homologous-serum hepatitis.

DISCUSSION

There is no method whereby homologous-serum hepatitis can be differentiated from any other type of virus hepatitis. In fact, as previously noted, the two diseases are very likely the same, except that the mode of transmission in the former case specifically entails parenteral inoculation of blood or blood products from a person harboring the virus. The donor of this disease need not have had a history of jaundice or any other medical history suggesting liver disease. Furthermore, liver-function tests could very well be normal even when the virus is present. To date there is no simple method of determining whether a potential donor either of blood or bone is a carrier of the virus. The only possible precaution which can be exercised in either instance is interrogation of the patient to determine whether he has a history of jaundice and the rejection as donors of those who have.

Thus we see that there is no method whereby it can be proved that the jaundice which occurred in the recipient of the bank bone was transmitted by the blood components remaining in the bone-graft substance. One possible method of ascertaining this would have been to use a remaining portion of the bone-bank bone in another recipient. However, the morbidity and the small but nevertheless significant mortality rate in homologous-serum hepatitis contra-indicated such dedicated scientific objectivity. Furthermore, the mere fact that homologous-serum jaundice would not have developed in the hypothetical recipient would be no proof that he did not harbor the virus transmitted by the infected bone.

On the other hand, if the stylus used for the preoperative and postoperative blood count or the needles used to administer the pentothal anaesthesia or other hypodermic injections were the vectors in transmitting the virus, some common source of contamination must be considered, with the likelihood of other cases being derived from the same

source. This possibility was investigated and no record of other concomitant cases was uncovered. Suffice it to say, then, that even though in this specific case the bone-bank bone may not have been the villain in the transmission of the disease, nevertheless the hardiness of the virus and its ability to tolerate the bone-bank environment, be it refrigeration or merthiolate, makes the bone bank a possible source of transmission of the disease.

CONCLUSIONS

1. Homologous-serum hepatitis is a form of human hepatitis produced by the parenteral inoculation of human blood or its products containing the appropriate virus.

2. It has been estimated that as little as 1 per cent. of one cubic centimeter of contaminated blood is sufficient to introduce the disease into the recipient. Simple acupuncture has been known to transmit the disease through a contaminated needle.

3. It is reasonable to assume that the usual amount of bone used in any bone-grafting procedure will contain more than the minimum of blood required for transmission.

4. It has been shown that the properties of the offending virus allow it to survive the usual storage methods of refrigeration or immersion in merthiolate for a time well beyond that during which bank bone is routinely stored.

5. The same precautions as in selecting blood donors should be exercised in selecting bone donors.

6. Surgeons who utilize stored bone should be conversant with any newly discovered method whereby the presence of the hepatitis virus can be determined in a prospective donor of either blood or bone in any easy and practical way.

REFERENCES

1. Editorial: Jaundice Following Yellow Fever Vaccination. J. Am. Med. Assn., **119**: 1110, 1942.
2. Findlay, G. M., and MacCallum, F. O.: Note on Acute Hepatitis and Yellow Fever Immunization. Trans. Roy. Soc. Trop. Med. and Hyg., **31**: 297–308, 1937.
3. Havens, W. P., Jr.: Infectious Hepatitis. Medicine, **27**: 279–326, 1948.
4. Klatskin, Gerald: Personal communication.
5. Oliphant, J. W.; Gilliam, A. G.; and Larson, C. L.: Jaundice following Administration of Human Serum. Public Health Reports, **58** (2): 1233–1242, 1943.
6. Walker, D. W.: Some Epidemiological Aspects of Infectious Hepatitis in the U. S. Army. Am. J. Trop. Med., **25**: 75–82, 1945.

A POSITIONING FRAME FOR ORTHOPAEDIC SURGERY *

BY WILLIAM R. MILLER, M.D., WICHITA, KANSAS

From the Wichita Clinic, Wichita

Maintaining the position of a patient on the side or in the oblique position for operative treatment of the extremities is always difficult. Sandbags, folded blankets, and other similarly insecure contrivances are too frequently unsatisfactory for this purpose. To ensure stable support of the patient in these positions an inexpensive, easily adjustable, stable frame has been constructed and found to be very useful. It is especially convenient

* Exhibited in the Gadget Exhibit at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Chicago, Illinois, January 1953.

for surgery on the hip; but it also is helpful in any oblique positioning of the trunk when mechanical traction is not necessary, — such as subtalar arthrodesis, intramedullary nailing of the femoral shaft, removal of donor bone from the ilium, or operations of the shoulder.

The frame is made of strap iron, gas pipe, and cap screws to simulate an adjustable trough. There are two thirty-inch pieces of five-eighths-inch gas pipe which lie parallel. They are connected at each end by a piece of strap iron in such a manner that the space between them may be varied. On each basic parallel pipe are several upright lengths of pipe which are adjustable along the parallel pipes. The uprights also may be rotated around the

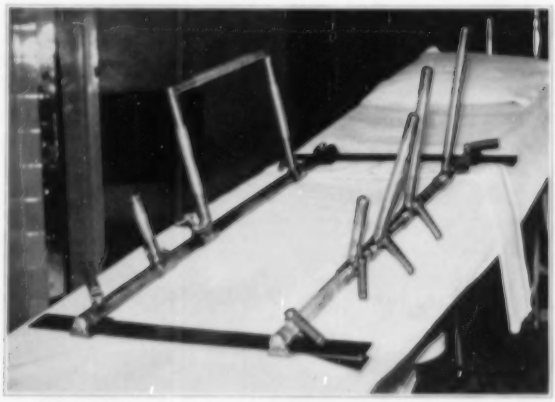

FIG. 1

FIG. 2-A

FIG. 2-B

basic pipes. Two of the uprights on one side are connected at their free ends by a third pipe twelve inches long. Cap screws serve to immobilize each part in the desired position and tightening of these is facilitated by a swivel handle attachment. The frame can be dismantled and removed without moving the patient. Figure 1 shows the frame assembled. Figures 2-A and 2-B show the frame holding a patient in the semiprone and semisupine positions, respectively. Padding has been omitted in these pictures in the interest of clarity of detail; however, when the frame is in use, folded blankets, towels, or other paddings are placed between the frame and the patient.

This basic and simple frame offers many opportunities for application of additional adjustments and refinements, such as variable height of the uprights, plates on the uprights, or straps between uprights to distribute pressure better. However, with proper adjustment of the uprights and at times the use of a folded towel for padding, no difficulties from pressure have been encountered.

AUTOSTATIC SEPARATOR FOR ARTHRODESIS

BY ISIDRO CASTILLO ODENA, M.D., BUENOS AIRES, ARGENTINA

From the Orthopaedic and Traumatological Service, Policlinico Argerich, Buenos Aires

In the performance of an intra-articular arthrodesis, it is essential that the joint surfaces be completely denuded. If small islands of cartilage are left or if the denuded joint surfaces do not fit together accurately, the development of firm synosteosis is impeded. If fusion is not solid and motion occurs, pain may result, making the operation unsuccessful.

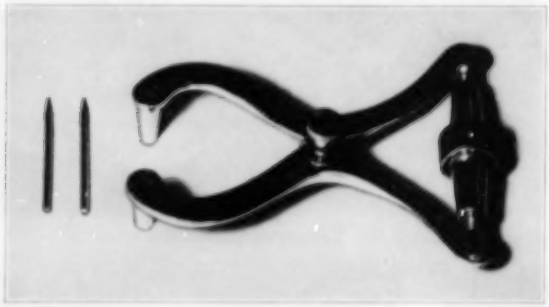

FIG. 1

The removal of the articular cartilage is not difficult in large joints, but in small joints or in those in which the joint surfaces are tightly approximated, as in the subtalar joint, the procedure is difficult. Solid fusion in the subtalar joint is particularly important because it must support the whole body weight. Failure of fusion will result in intolerable pain when the patient is walking.

FIG. 2-A

FIG. 2-B

To facilitate the exposure of the articular surfaces, an autostatic separator has been invented (Fig. 1). Two small headless nails, five centimeters in length and three millimeters in diameter, are partially inserted, parallel to each other, one into the body of the talus and the other into the calcaneus. The projecting ends of both nails are then introduced into the articular separator, the arms of which are activated by a screw of double and inversed pitch. Once the nails have been placed, the arms of the separator are opened, and the articulation is exposed widely. Both articular superfacies are readily visualized (Figs. 2-A and 2-B), and the extirpation of the cartilage is permitted with a few strokes of the chisel.

THE OFFSET TROCHANTERIC JOINT IN BRACES FOR THE LOWER EXTREMITIES

BY ODON F. VON WERSSOWETZ, M.D., NASHVILLE, TENNESSEE

From the Physical Medicine Rehabilitation Service, Thayer Veterans Administration Hospital, and the Department of Physical Medicine, Meharry Medical College, Nashville

In braces for the lower extremities, a trochanteric joint is not used routinely for stabilization of the hips in paraplegia and monoplegia following cord injuries, poliomyelitis, hemiplegia, or other disabilities of the locomotor system, because it does not provide sufficient support and does not prevent postural malalignment. Most cases in which a free trochanteric joint is used show the posture of the patient to have an excessive lordosis. To a certain degree, this posture is necessary to stabilize the hips on locomotion; this, however, puts a severe stress on the hip ligaments and the lumbar spine. To prevent this undesired condition, an offset trochanteric joint may be used successfully. This joint is a modification of the one used by Canty[1] for the knee.

The basic principle of an offset joint is the placing of its axis on one side of the load line and the weight-bearing force on the other. This provides a simple mechanical advantage by producing a

FIG. 1

Fig. 1: Lower-extremity braces with pelvic band, worn by a paraplegic patient who has urinary incontinence.

Fig. 2-A: Offset-joint arrangement for limiting hyperextension.

Fig. 2-B: Offset joint showing free flexion.

FIG. 2-A FIG. 2-B

locking force on weight-bearing. The effect is an increased stability.

The offset trochanteric joint is constructed of curved bars that are hinged as illustrated in Figure 1. Hyperextension is blocked and controlled by a metal stop, which permits only a slight degree of motion posterior to the line of gravity and free flexion as seen in Figure 2-B. In this way, stability on locomotion is assured, yet free mobility of the joint is preserved. This type of joint is used in conjunction with a pelvic band or a back brace.

This joint has been used successfully for a number of patients having moderately severe weakness of the pelvic girdle and lower abdominal muscles. Usually, these muscle groups are able to move the hip through almost a complete functional range of motion, yet they do not possess sufficient power to stabilize it on weight-bearing without causing the patient to assume a bad posture, resulting in skeletal malalignment. The offset trochanteric joints permit the patient to walk more naturally with a much improved gait pattern compared to that ordinarily seen in patients wearing a brace equipped with either free or locked hip hinges.

NOTE: The offset joints illustrated were devised and constructed by Wallace Slodek, Supervisor, Orthopaedic Brace Shop, Thayer Veterans Administration Hospital, Nashville, Tennessee.

1. CANTY, T. J.: Functional Full Length Leg Brace. Am. J. Surg., **81**: 474–480. 1951.

A SELF-RETAINING LAMINECTOMY RETRACTOR

BY W. C. PETERSON, M.D., ALBUQUERQUE, NEW MEXICO

In the course of performing laminectomies and fusions on adult patients, and particularly in the presence of scoliosis in adults or in children, the author has been aware of his inability to maintain good exposure because of the inflexibility of the various self-retaining retractors available. Some retractors are built with blades of variable length, but these instruments are usually bulky and tend to interfere with the surgeon's access to the area of operation.

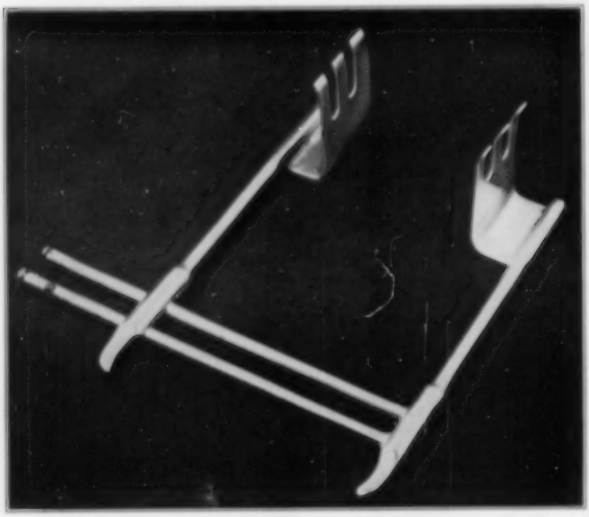

FIG. 1

The retractor with the blades in one plane.

With these facts in mind, the following modifications of the Frazier type of retractor were carried out. Two round bars were used as a slide mechanism to give better retaining power. They were fixed at only one end to provide flexibility and to allow rotation of the blades to various depths. This rotation also

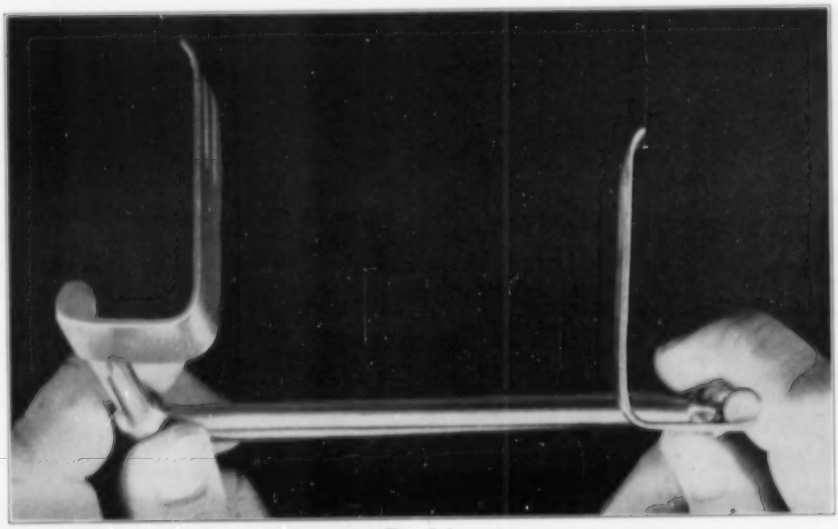

FIG. 2-A

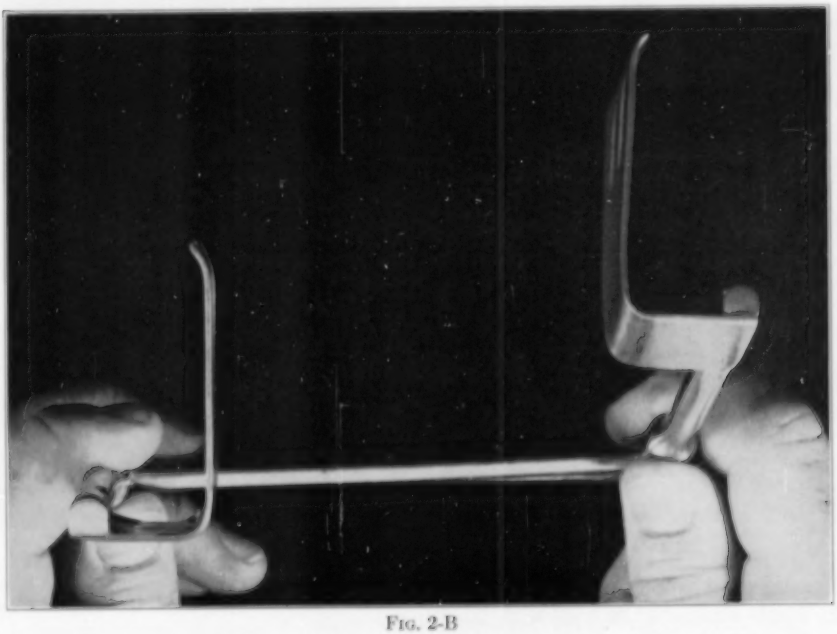

FIG. 2-B

The extent to which the blades can be rotated for various depths of retraction.

allowed the blades to be inserted to correspond to the particular degree of rotation of the spine. The blades were modified to give better holding power as well as better visibility. This instrument has been in use for the past twelve years, and has proved its value and its versatility.

A NEW BONE CLAMP *

BY JOSEPH LICHTOR, M.D., KANSAS CITY, MISSOURI

Three-point fixation for the clamping of cylindrical objects is a mechanically sound practice used in orthopaedic surgery. One of the best examples is the Lowman bone clamp. There are certain disadvantages in this instrument, however, inherent mainly in the screw mechanism that is used to approximate the jaws of the clamp. The screw element is necessarily at a 90-degree angle to the jaws, so that it acts as an obstruction at the surgical working level and is unwieldy in application and release.

A three-point fixation clamp has been adapted to fit a "lever-action" wrench. The jaws are fixed at a 165-degree angle to the handle, permitting easy application; after the wrench is in position, it is at a 90-degree angle to the working level, and acts as a retractor of the soft tissues (Fig. 1). Adjustment to size is easily made by turning the screw which protrudes from the top of the wrench handle (Fig. 2).

FIG. 1

FIG. 2

For ease and proper function, the clamp should be operated as follows:

1. Apply clamp to the bone with jaws open.
2. Close the handles; the jaws are still loose.
3. Turn the screw to the right until it is tight so that both jaws come into contact with the bone.
4. Open the handles and then give the screw one quarter turn to the right to provide the proper amount of compression force when the jaws are closed.
5. Close the handles.

The mechanics embodied in the lever-action wrench provides easy application, great strength, rapid adjustability, and quick release. The original clamp was the large size for tibiae and femora, but smaller ones are easily made for other bones.

* Shown in the Gadget Exhibit at the Annual Meeting of The American Academy of Orthopaedic Surgeons, Chicago, Illinois, January 1953.

Proceedings

WESTERN ORTHOPEDIC ASSOCIATION

The Seventeenth Annual Meeting of the Western Orthopedic Association was held at Sun Valley, Idaho, October 4 to 8, 1953, and broke all previous attendance records. Over five hundred members and guests enjoyed the hospitality of this world famous resort on the western slopes of the Rockies. The Scientific Sessions were held daily from 9:00 A.M. to 4:00 P.M.

By way of entertainment, there were ice skating, swimming, bicycle riding, fishing, golf, trap shooting, and horseback riding. On the second night there was a barbecue at the Trail House at which real buffalo meat was the *pièce de résistance*.

At the continental cabaret dinner on the following evening, prizes were awarded to the outstanding athletes. The social activities terminated with a farewell cocktail party and an informal dinner dance.

Dr. Leonard Barnard of Oakland, President for 1954, assumed the chair at the final business meeting and announced that the next Annual Meeting will convene in San Francisco, California, in the fall of 1954. Dr. Douglas Toffelmeier and Dr. Harry Walker, both of Oakland, California, were named Secretary and Treasurer, while the Editorial Committee, under the chairmanship of Dr. Merrill Mensor, was left unchanged.

At this meeting a resolution was passed supporting the action of the American Medical Association, The American Orthopaedic Association, and The American Academy of Orthopaedic Surgeons in their efforts to keep the program of rehabilitation in the hands of the men who have raised it to its present state.

Dr. J. Warren White was elected the President-Elect, and Hawaii was selected as the place of the 1955 meeting.

The following are abstracts of the scientific papers and discussions presented at the meeting.

SUNDAY AFTERNOON, OCTOBER 4, 1953

The Mechanism of Nerve-Root Compression in Spondylolisthesis and in Spina Bifida Occulta as Revealed at Surgery. DR. GERALD G. GILL [1] and DR. HUGH L. WHITE [2] believe that the symptoms of spondylolisthesis are due to nerve-root compression and irritation caused by two mechanisms. The first occurs on extension of the back when the loose lamina may rock downward and cause traction on the first sacral-nerve root as it passes across the sacrum. The second, the more common, is due to compression of the fifth lumbar-nerve root by a mass of bone and fibrocartilaginous tissue found at the pseudarthrosis in the pedicle of the fifth lumbar vertebra. Initially, the authors performed decompression of the nerve roots followed by fusion laterally. However, in thirteen patients, surgery was confined to the removal of the loose lamina and fibrocartilaginous tissue alone. In four other patients, when spine fusion had failed to result either in fusion or in relief of symptoms, excision of the fusion mass, with facetectomy and decompression of the roots, had given relief. In one patient, despite solid fusion, symptoms persisted until the fibrocartilaginous mass was removed.

In spina bifida occulta of the first sacral segment, the spinous process of the first sacral vertebra is not rigidly supported, but lies upon a diaphragm of ligamentum flavum. With a hyperextension injury, this may be pushed downward against the dura and the sacral-nerve roots, as was demonstrated in the moving picture. Treatment by excision of these spinous processes was advised.

The Surgical Technique for Arthrodesis of the Adult Hip. DR. DON E. KING [3] presented a motion picture illustrating the technique for arthrodesis of the adult non-tuberculous hip. An intra-articular fusion was performed. This was supplemented by:

1. Internal fixation by means of a Smith-Petersen nail which was inserted through a lateral incision;

2. A triangular bone graft which had been cut from the anterior crest of the tibia on the affected side and which was inserted into a slot cut in the superior aspect of the greater trochanter, neck, head, and acetabulum;

3. A full-thickness iliac-bone graft which had been obtained from the adjacent ilium and which was secured to the previously prepared anterior surface of the acetabulum, head, neck, and intertrochanteric area by two screws.

Finally, bone chips were placed about the grafts. Immobilization in a double hip spica, which was changed ten days after the operation in order to ensure a snug fit, was maintained for ten weeks. In fifteen patients, including two with aseptic necrosis, there had been but one failure. In very elderly patients, the author had not performed the intra-articular part of the fusion procedure, yet satisfactory fusion was secured.

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[2] 655 Sutter Street, San Francisco, California.
[3] 2361 Clay Street, San Francisco, California.

Techniques in Physical Therapy and Rehabilitation. Dr. Manley B. Shaw [4] presented a motion picture on physical rehabilitation which had been prepared under the supervision of the Orthopaedic Staff of the Elks' Convalescent Home, Boise, Idaho.

The Treatment of Acromioclavicular Separation. Dr. Leonard Barnard [5] presented a film demonstrating a method of treating acute separations of the acromioclavicular joint. The author advised the use of a closed shoulder spica with the arm held in adduction and the incorporation in the spica of compression dressings, so as to exert downward pressure on the outer end of the clavicle and an upward thrust on the humerus at the elbow. He has used this method for over twenty years with uniformly good results in patients in whom reduction could be obtained. Operative treatment for ligamentous injuries in all parts of the body was decried. Failure of conservative treatment was considered to be due to inadequate fixation.

Monday, October 5, 1953

An Improved Method of Fusing the Spine. Dr. John R. Vasko [6] made a preliminary report of a promising procedure for spine fusion which he has used in seventeen cases. After superficial decortication of the laminae of the lumbar vertebrae and the sacrum, the laminae were split in a frontal plane, a ledge of bone was pried up, and an opening was placed medially. Strips of bone, removed from the outer side of the iliac crest, were then placed in the laminar and sacral crevices and were tapped into place rather solidly. Additional procedures were always carried out. These included wedging procedures which were performed on each side of the spinous processes and fixation of the bone to one side of the spinous processes with screws. The apophyseal joints were treated in various ways, small grafts being placed across the apophyseal joint in one way or another. Additional bone chips were packed over the laminae in all instances.

A close-fitting plaster jacket was applied as immobilization for four months after the operation. This was followed by a chair-back brace or corset, which was gradually discontinued.

Arthrodesis of the Lumbosacral Spine. Dr. Lewis M. Overton [7] presented an end-result study of ninety-one patients operated upon between 1948 and 1952. The operative technique was that published by the author in 1950, but it had then been modified to include the McBride facet bone block combined with a larger amount of cancellous bone packed over the entire denuded lamina and posterior facet area. In five patients with spondylolisthesis the entire lamina was removed, and the nerve roots were completely decompressed.

All the patients had been treated conservatively without relief prior to operation.

In the evaluation of results, the presence of a strong back, absence of localized tenderness, free mobility above the arthrodesed area, freedom from pain on activity, and the ability to return to former work after the operation were used as criteria to determine the success of the procedure. Lateral roentgenograms made with the spine in forced flexion and forced extension were used to determine the solidity of the fusion.

Eighty-three patients were followed eighteen months or longer. They were then examined for the determination of the end results. Free motion above the grafted area was present in seventy-nine of the eighty-three patients, while twelve patients complained of mild discomfort, and three complained of moderate pain following exertion. Lumbosacral tenderness was present in four patients. Seventy-one patients had no complaints and felt that their backs were strong. Seventy-seven patients had returned to work without any limitations. Roentgenograms revealed pseudarthroses at both the fourth and fifth lumbar interspaces in one patient and at the fourth lumbar interspace in three. Solid fusion was, therefore, obtained in approximately 95.2 per cent. of this series. The importance of careful selection of cases, meticulous operative technique, and careful postoperative follow-up was stressed.

Vertebral-Body Fusion. Dr. Ralph B. Cloward [8] expressed the opinion that any patient with low-back pain, with or without sciatica, which is found to be due to a ruptured intervertebral disc should be subjected to spine fusion. The possibility that a painless, useful back may be obtained is considered greater if the removal of the protruding intervertebral disc is accompanied by spine fusion. The author's operative technique is as follows: The intervertebral disc is completely removed through the spinal canal with the aid of such special instruments as a lamina spreader and a self-retaining dural retractor. Three or four iliac-crest grafts from the bone bank are then driven into the intervertebral space, and additional bone grafts are placed over the posterior neural arches.

In a series of over 400 patients, 87 to 92 per cent. are symptom-free and are able to do work comparable to that done before injury. Failure of fusion occurred in 3 per cent. of the patients. The operation has been used in sixteen patients with spondylolisthesis with one failure. Complications following this procedure were not discussed.

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[5] 2939 Summit, Oakland, California.
[6] 475 30th Street, Oakland, California.
[7] First National Bank Building, Albuquerque, New Mexico.
[8] 1013 Bishop Street, Honolulu 13, Hawaii.

In discussing the preceding papers, DR. A. G. KIMBERLEY [9] stressed the importance of the proper selection of cases and the determination of whether a spine fusion, a laminectomy, or a combined procedure was indicated. He considered that Dr. Overton's technique complicates matters unnecessarily and that his method is not always applicable. Regarding Dr. Vasco's method, he pointed out the technical difficulties of such a procedure. He considered Dr. Cloward's procedure for vertebral-body fusion a more formidable procedure than fusion of the posterior spinal elements. He stressed the dangers of scar formation resulting from the fusion itself, from trauma to the dural sac and spinal nerves, from the extensive cauterization of extradural vessels, and from the careless use of instruments beyond the boundaries of the disc. He concluded that the results from this procedure were no better than those obtained by competent surgeons from fusions of the posterior elements of the spine and that the greater risk was not justified.

DR. DON KING [8] complimented Dr. Overton on his great success in the obtaining of bony fusion. He considered this to result from the careful selection of cases, meticulous operative technique as regards facet fusion, and painstaking postoperative care. Dr. King regarded Dr. Cloward's technique as revolutionary and questioned whether it was wise or desirable to make such a radical change in the present technique.

Skeletal Trauma in Infants: Unusual Metaphyseal Manifestations. DR. J. VERNON LUCK [10] reported eight patients with an average age of 10.5 months who showed some unusual manifestations of trauma, particularly in the metaphyses of the long bones These consisted chiefly in subperiosteal ossification and metaphyseal porosis. Such changes have often been erroneously interpreted as due to scurvy, syphilis, Caffey's disease, hypervitaminosis A, pyogenic osteomyelitis, skeletal dystrophies, and osteosarcoma. In three of these patients, trauma had been inflicted by the parents, but this had not been admitted in the routine history. This entity can be readily recognized once one becomes familiar with its features. Special laboratory studies and biopsies are not necessary. The prognosis is excellent as regards rapid healing.

Only symptomatic and supportive therapy is required, and no attempt should be made to reduce the rotated or displaced epiphyses. Natural processes, in this instance, do better without meddlesome manipulations.

Choice of Methods of Internal Fixation of the Shaft of Long Bones. DR. RALPH SOTO-HALL [11], DR. NEIL P. MCCLOY [12], and DR. H. LILLO [13] presented a study of 200 consecutive fractures of the long bones treated by open reduction and internal fixation over a period of fifteen years. The results were compared with an ideal standard to be attained by the use of devices for internal fixation Standards of measurement were defined, and delayed union was considered to be present if union was not complete in five months. Failure of bone to unite within seven months was classified as non-union.

One hundred and forty-four of the 200 cases tabulated had complete and thorough follow-up data.

The types of fixation used were:

Intramedullary	75 cases
Plate	30 cases
Smith-Petersen nail and plates	3 cases
Screws and wires	79 cases
Other small appliances	13 cases

In the treatment of twenty-five humeral-shaft fractures, Rush nailing gave the best results. Plate fixation gave nearly as good results. A Rush nail with supplemental wiring was thought to be the method of choice, although there had been some slight limitation of shoulder motion due to the protrusion of the proximal "hook" of the nail.

In nineteen cases of forearm fracture with complete records of results, fixation by a Rush nail in the ulna, combined with the use of small appliances (such as wires or plates) for the radius when both bones were involved, gave the best results. The use of a Rush nail in both bones did not seem warranted, except in segmental or comminuted fractures. A Rush nail alone in the radius was found not to stop rotation at the fracture site.

Fifty-one cases of fracture of the femoral shaft were available for complete analysis. Fractures high in the upper third of the femur were best treated by plating. The cloverleaf intramedullary rod gave excellent results in fractures of the middle third of the shaft and was the authors' first choice for the treatment of fracture at this site.

Analysis of forty-six tibial-shaft fractures indicated that cross screws and plating must remain the treatment of choice until more experience has been gained with intramedullary methods.

When fractures of the shaft of the fibula near the ankle require internal fixation, the Rush nail can be used to advantage in the maintenance of the normal width of the joint mortise.

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[10] 1930 Wilshire Boulevard, Los Angeles 5, California.
[11] 350 Post Street, San Francisco, California.
[12] 350 Post Street, San Francisco, California.
[13] Chile. (By invitation)

A New Method of Treatment of Fracture-Dislocation of the First Metacarpal Bone. Comdr. Howell E. Wiggins [14], Comdr. Warner D. Bundens [15], and Dr. Byron J. Park[16] presented a new method for the treatment of fracture-dislocation of the first metacarpal (Bennett's fracture). An intramedullary Kirschner wire is inserted through the head of the metacarpal into the greater multangular. The method is simple and gives stable fixation with the thumb splinted in a position of optimum function.

In the discussion of the preceding papers, Dr. Alonzo Neufeld [17] noted that the traumatic metaphyseal lesions of infancy heal rapidly without any residual deformity or disability. Concerning the paper by Dr. Soto-Hall and his associates, he emphasized that internal fixation should be chosen for specific reasons and only if it offers advantages over more conventional methods. He suggested that complete restoration of the original trabecular patterns does not occur with internal fixation at times because of the continued splinting effect of the rod. Consequently the bone is suited for pressure stresses but not for rotatory or tension stresses. The method of treatment of fractures should be chosen with this in mind in order that normal bone may result. Regarding the treatment of Bennett's fracture, he expressed concern over the running of a wire across the joint of the thumb.

Dr. Douglas D. Toffelmeier [18] noted that such lesions as Cooley's anaemia, osteosclerotic leukaemia, and foetal rickets may present a roentgenographic picture similar to that seen in traumatic metaphyseal lesions. With regard to Bennett's fracture, he stated that treatment by traction is complicated in patients with a hypermobile thumb, for adequate counter-pressure is not maintained. He observed that an untreated fracture of this type does not always result in a painful thumb. Many such fractures are never recognized and tend to heal without undue disability.

Cross Bone-Grafting between the Fibula and the Tibia for Tibial-Bone Defects. Dr. Paul E. McMaster [19] presented a method for the treatment of non-union of tibial fractures, resulting from wounds with immediate loss of bone substance, or from the surgical removal of bone in infected fractures. Various procedures have been used, including leg-shortening and bone-grafting, in order to bridge the tibial defect. All of these are either not desirable or unsuccessful because of the breakdown of the scarred soft tissues or because of the failure of the bone graft to bridge the defect and to become vascularized.

It was thought that, if adequate bony union could be obtained by cross bone-grafting between the intact fibula and the two tibial fragments, weight-bearing would be possible through the proximal tibial fragment to the fibula and hence back to the distal tibial fragment. This procedure presupposes that the intact fibula will maintain leg length.

The fibula can usually be approached with safety on the lateral side as scar tissue there is rarely a prominent feature. Drill holes are made through the fibula inward and upward into the distal portion of the proximal tibial fragment and inward and downward into the proximal portion of the distal tibial fragment. Into these drill holes are driven cortical bone grafts of either autogenous or bank bone, three or four grafts being placed in each fragment. The lateral surface of the fibula spanning the tibial defect is then freshened and reenforced with onlay grafts. Finally, two small incisions are made over the proximal and over the distal portions of the fibula. Drill holes are then made through the fibula into the tibia, and cortical bone grafts are inserted. The drill used in each instance should be as large as possible, up to a quarter of an inch, but not so large as to split the fibula.

The wounds are closed in layers and a long cast is applied to the extremity and is kept on for three to six months. When there is evidence of consolidation of the grafts, weight-bearing in the cast is allowed. Later a long brace on the extremity can be used.

In discussing Dr. McMaster's paper, Dr. Lawrence Noall [20] expressed the opinion that the method has real merit since it demands double fixation of the fibula to each tibial fragment without making necessary the extensive dissection of the relatively avascular area of the defect.

Release of the Rectus Femoris in Spastic Paralysis. Dr. William R. Duncan [21] presented a preliminary report on the treatment of flexion deformities of the hip, knee, and ankle in thirty-two patients with cerebral palsy by release of the rectus femoris at its upper end. Contracture of the rectus femoris was considered present if, with the patient in the supine position, the knee could not be passively flexed beyond 90 degrees with the hip in full extension, while with the hip flexed normal knee flexion was possible or if, with the patient in the prone position, passive flexion of the knee caused the pelvis to rise from the examining table. Postoperatively, striking postural changes occurred including reduction of the lumbar lordosis, relaxation of the hamstrings due to the lowering of the ischial origin, and correction of the flexion contracture of the knees. There

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was a marked improvement of the standing and sitting postures, often with a gain in height of two to four inches. The patients were able to get their feet flat on the ground, whereas previously the entire weight had been on the fore part of the foot.

Twenty-one patients were studied at follow-up. The average age was 11.8 years. The average post-operative interval was twelve months, the shortest being four months and the longest nineteen months. There were sixteen patients with spasticity, three with rigidity, and two with tension athetosis. Twelve were of normal mentality; five were of borderline mentality; and four were seriously retarded. Parents of these patients reported as follows: Thirteen parents felt that their child was greatly improved; four felt that he was somewhat improved; four felt that he was slightly improved; none felt that the child was unchanged or worse. The improvements noted were: "sitting posture improved" by nine, "legs softer" by nine, "walks better" by eight, "heels on floor" by six, "knees straighter" by six, "gain in height" (two to four inches) by four, and "able to spread legs" by three. Undesirable results were: "increased fear of falling" reported by two, and "convulsions since surgery" reported by one.

Seven of the twenty-one patients passed through one major stage of motor development. These included the two patients who were bed-ridden preoperatively and who were now able to crawl; five of the twelve patients who were unable to walk prior to surgery were walking three months after surgery.

Increased active extension of the knee occurred in thirteen, and a reduction of the hip-flexion deformity occurred in nine. Contracture of the rectus femoris was eliminated in eighteen patients, but this recurred in two and was equivocal in one. Two patients showed mild weakness of the quadriceps, and in two increased contracture of the hamstrings developed.

The procedure was considered useful in the adolescent spastic patient. It was thought to be of value in the younger patient with severe "extensor-thrust" or with impending dislocation of the hips. The results in patients with rigidity were poor and the results were only slightly better in patients with tension athetosis.

The Treatment of Non-Paralytic Poliomyelitis. Dr. Robert Bingham [22] and Dr. Dean Lindgren [23] reported on their results in the treatment of sixty-two cases of non-paralytic poliomyelitis. Treatment consisted in bed rest, six to eight hours of wrap-around hot packs daily, and passive exercises carried out to the point of discomfort. This was continued for twelve to ninety days, or until the patients were completely flexible and muscle function had returned. "Muscle spasm" or "pain and tightness" was present in every patient, and forty-two patients showed "incoordination" or temporary functional impairment without localized weakness. No deformities resulted in patients on this regimen. The importance of long-term supervision, especially in children, was stressed.

Dr. Roscoe Mosiman [24], in discussion, pointed out that the major cause of deformity in poliomyelitis is muscle imbalance rather than muscle "spasm". He noted also that the source of muscle tightness in poliomyelitis is still in doubt.

Surgical Rehabilitation of the Rheumatoid Hand. Dr. O. R. Walter [25], Dr. R. H. Hall [26], and Dr. S. S. Mathews [27] described their operative technique for the correction of rheumatoid deformities of the radiocarpal and metacarpophalangeal joints. At the wrist, deformity consists in anterior flexion with radial or ulnar deviation or subluxation. The metacarpophalangeal-joint deformities are remarkably uniform and consist in flexion contracture, palmar subluxation, and ulnar deviation.

When indicated by severe deformity and limitation of motion, a Vitallium prosthesis was used to replace the deformed distal portion of the radius. The metacarpophalangeal-joint deformities were corrected by the revision of the metacarpal heads to the level of their anatomical necks, the stripping of the joint capsules from the volar aspect of the joints, and the repositioning of the proximal phalanges upon the revised metacarpal heads without tension. The ulnar deviation was then corrected by the division of all of the interossei, the tendons of which insert on the ulnar aspect of the proximal phalanges, and by the shortening by imbrication of all interossei on the radial side. The corrected position was maintained for one to two weeks in a plaster mold. Nine hands had been treated in this manner. Recurrence of deformity was negligible and a marked decrease in pain resulted.

The Criss-Cross Abdominal Fascial Transplant. Dr. C. L. Lowman [28] described the operative technique for the criss-cross abdominal fascial transplant in poliomyelitis. The procedure is indicated for total abdominal paralysis and should be done very early, three to four months after onset, except in children under five or in patients who have been in a respirator and have not yet developed enough vital capacity to make them fair surgical risks. Intratracheal anaesthesia should be used.

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The purpose of this operation is to supply resistance to the downward thrust of the diaphragm, thus improving the flow of venous blood back to the heart, to restore the ability to cough and to assist in evacuating the bladder and bowels, and to prevent the widening of the gap in the kinetic chain as described by Dr. Steindler. Loss of function of the abdominal muscles promotes the shortening of the other trunk fixators.

For example, with the spinal muscles intact and unopposed by the abdominal muscles, every effort to raise the legs or to use the arms increases the lordosis which develops in these patients. If the quadratus lumborum and latissimus dorsi are stronger on one side than on the other, a lateral tilt and scoliosis will result. Adaptive shortening of the hip flexors occurs because the front of the pelvis cannot be supported.

In patients with extensive trunk paralysis, the earliest reconstructive procedures should be repair of the abdominal wall by fascial transplant and correction of shoulder-girdle malposition by means of a fascial band between the scapulae. These operations are indicated because there is no way of splinting the abdomen or the scapulae against the pull of gravity and unbalanced muscle action.

In discussing Dr. Lowman's paper, Dr. Joseph C. Risser [29] stated that in his experience the best results after abdominal fascial transplantations were in adults with abdominal paralysis and without involvement of the back and in children with an associated round-back deformity. In his opinion, abdominal fascial transplantations would not prevent progression of a curvature of the spine, because this is primarily a growth deformity. He noted that the non-operative treatment of this condition has been by means of an antigravity body cast which strengthens the spine by correcting the anteroposterior curvature and by permitting shortening of the paralyzed muscles.

Dr. Alvin Brockway [30] stated that the procedure has been in use long enough to have been properly tested. He stressed that, in addition, a second fascial transplantation should be done from the mid-lateral line to the abdomen on both sides. This will enable the patient to lift his legs forward much better. Finally he noted that postoperative breathing difficulties may occur and should be watched for.

The Use of Towels During an Orthopaedic Operation. A Controlled Study. Dr. Lewis Cozen [31] and Dr. Robert Mazet, Jr.,[32] reported the results from wound cultures in consecutive clean surgical procedures performed at the Wadsworth General (Veterans Administration) Hospital, Los Angeles. Approximately 180 operations were studied. In half of these, skin towels and towel clips were used to cover the wound edges, while in the other half the skin was merely prepared with the usual antiseptic solution. All operations required one hour or more to perform. The incidence of positive wound cultures and of infection after the operation was approximately the same in the two groups. It was concluded that towels and towel clips on the edges of clean, operative, orthopaedic wounds do not significantly diminish the incidence of wound infection.

In discussion Dr. Harold E. Crowe [33] recalled an experiment by Dr. Frank Mellon in 1928 which showed that infections in surgical wounds come from the mouth and nose of the surgeon. He stated that he had not draped the skin edges in the last seven years but that he had used instead a sterile stocking tube. He could not recall any surgical infection during this period, and he commented on the importance of prophylactic antibiotics.

Tuesday, October 6, 1953

Arthroplasties of the Hip with Vitallium Cup. Dr. H. E. Emmel [34] reported an end-result study which included nine patients who had been subjected to cup arthroplasties and followed for one to three years. He concluded that the indications for an arthroplasty of the hip were increasing pain and pain at night which interfered with sleep, marked deformity, and instability of the hip joint. He also concluded that the procedure could be done best through the posterolateral approach. In all patients as much of the capsule as possible was removed in order to eradicate pain-bearing fibers. In nearly all of these patients, the trochanter was transplanted downward onto the shaft of the femur about 1.9 centimeters in order to establish a better mechanical relationship for the abductor muscles. Nothing was done to the acetabulum except in those patients in whom it was obviously indicated, as in a congenitally shallow acetabulum or in old Perthes' disease with an inadequate acetabulum. In all patients pain was relieved by as much as 75 to 95 per cent., according to the patients' statements; the range of motion was improved, and the stability was maintained. No serious complications were encountered, and there were no deaths. The author concluded that Vitallium-cup arthroplasty is the procedure of choice in patients in whom there is sufficient length of femoral neck.

Fracture-Dislocation of the Shoulder Treated by Replacement Prosthesis. Dr. Charles W. Gilfillan [35] and Dr. Richard Scandalis [36] reported on the use of a replacement prosthesis for fracture-dislocation of the

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humeral head. This injury invariably leads to avascular necrosis of the head fragment. The removal of the humeral head or reduction and internal fixation of the fragments has produced disappointing results.

Arthroplasty in which a large, especially designed, acrylic shoulder prosthesis is used, as suggested by Judet, Renée, and Richard, involves the sacrifice of a considerable amount of bone and the transplantation of the rotator-cuff tendons. The use of a small Judet type of femoral head eliminates the necessity for the removal of additional bone and the transplantation of the rotator tendons. A case report with a twelve-month follow-up was presented. The patient was a woman, thirty-eight years old, who had suffered a fracture of the anatomical neck of the humerus with dislocation of the head. After closed reduction failed, a small 43-60 Judet hip prosthesis was used as a replacement. Postoperative care included intensive physical therapy. Twelve months after surgery, an 80 per cent. return of function was seen.

In discussing the preceding two papers, Dr. J. Warren White [37] expressed his conviction that the hip prosthesis is here to stay, but he noted that it is encumbent on the surgeon to consider the use of interposed material, such as a Vitallium cup, when pain rather than loss of tissue requires surgical intervention in hip disease.

Dr. John C. Wilson [38] stated that the Vitallium mold has, without question, a place in the armamentarium of the orthopaedic surgeon, although the results with its use have not been good in the treatment of degenerative arthritis in the middle-aged patient or in the elderly patient, nor have the results been good in the treatment of rheumatoid arthritis. He expressed a note of caution with regard to hip prostheses when he questioned whether a foreign body attached to living bone will be found to stand up under the stresses to which it is subjected.

Short Tarsal Amputation Reconstruction. Dr. Robert Garrett [39] presented a case report concerning a twenty-nine-year-old woman who had suffered the loss of the fore part of her foot through the mid-portions of the navicular and cuboid. The foot which resulted was not a serviceable part, because of equinus deformity and possible complication from weight-bearing on the sensitive scar. Reconstruction was done by means of a subtalar fusion, and a shifting of the calcaneus about 2.5 centimeters forward, thus weakening the gastrocnemius and soleus muscles. One screw through the cuboid into the talus was used for fixation. The peroneus longus tendon was transferred after the manner of Mayer to act as a dorsiflexor while the tibialis posterior tendon was displaced to act as a dorsiflexor by transfer to a subcutaneous position above the malleolus. After immobilization in a short leg cast for two months, with weight-bearing in the cast begun after three weeks, union was complete and the ankle was mobilized. The amputation stump was fitted with an acrylic bucket with a felt extension for the fore part of the foot, a toe break, and a leather upper extension to just above the ankle fitted with a zipper to maintain the prosthesis in place. The functional result was quite satisfactory, for the patient now bears weight on this prosthesis twelve to fourteen hours a day. The cosmetic result has also been very gratifying.

Hindquarter Amputations. Dr. Orville N. Jones [40] and Dr. Robert A. Wise [41] reported their results with fifteen hindquarter amputations. Fourteen were done in the treatment of malignant conditions and one was done in the treatment of gangrene following traumatic thrombosis of the common iliac artery. Six of the patients were still alive; one who had chondrosarcoma of the ilium was alive six years after the operation. The authors made the following points:

1. The procedure is best performed by a combined team of orthopaedic surgeon and general surgeon;
2. The patient should be placed in full lateral position, and he should not be moved during surgery;
3. Control of deep bleeding in the perineal stage of the procedure can be effected by a temporary tourniquet on the common iliac artery;
4. Adequate replacement of blood loss is imperative.

The authors made a strong plea that this procedure be chosen in preference to allowing the patient to die under "conservative" management.

In discussion of the preceding papers, Dr. Charles Hutter [42] stated that the procedure advocated by Dr. Garrett will prove of greatest value in women who dislike the Syme amputation because the prosthesis is ugly and ungainly. Women will accept the loss of a "take-off" in this type of operation, whereas men will prefer the "take-off" offered by the Syme prosthesis. He warned against a transtarsal type of amputation in an active young man because of the trouble given the amputee by the Chopart prosthesis.

Although hemipelvectomy is not a heroic procedure, indications for it are still not clear. A comfortable pelvic support is necessary for the fitting of a satisfactory prosthesis for these patients. By shifting a part of the weight to the opposite ischium, this may be achieved.

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Dr. Donald Slocum [42] pointed out that the posterior shift of the talus on the calcaneus accomplished the dual purpose of the centering of the superincumbent weight over the weight-bearing surface and the lengthening of the bone framework distally producing a more efficient stump to which a prosthesis can be fitted.

In hemipelvectomy, he emphasized the value of the patient being in the full lateral position with his extremity suspended from above. With the patient in this position, the pelvis and extremity are readily accessible to the surgeon and the peritoneal contents fall away from the incisional wound. Furthermore, both an anterior surgical team and a posterior team can work simultaneously without interfering with one another.

Surgical Treatment of Injury to the Talofibular Collateral Ligament of the Ankle. Dr. Kirk J. Anderson [41] reported the results of a study of twenty-seven patients with unstable ankle joints following sprains, who were treated by operation. The average follow-up period was fifteen months. Two types of instability were treated: (1) anterior subluxation of the talus due to rupture of the anterior talofibular ligament (twelve patients); and (2) gross instability due to injury to the anterior talofibular, calcaneofibular, and posterior talofibular fasciculi (fifteen patients).

In two patients, primary repair of the ligaments by mattress sutures gave excellent results. In contrast three patients who were treated by plaster immobilization after their initial injury later required ligamentous reconstruction. Delayed repair with plication of the ligament was done successfully in one patient. Reconstruction was performed in twenty-four patients. In twenty-two the peroneus brevis tendon was utilized, as originally described by Watson-Jones. Instability was relieved in all but one instance, and full ankle motion was regained except for the loss of inversion of about 25 per cent. in ten patients. The results were inferior in two patients; in one in whom reconstruction was done by suturing the peroneus brevis tendon to itself just proximal to its insertion into the fifth metatarsal; in another, the ankle was treated by the procedure recently described by Watson-Jones in which the split peroneus longus tendon is used as a sling passed through the fibular malleolus, tibia, and neck of the talus.

Complications associated with ankle-joint subluxation were osteochondritis dissecans of the talus in six patients (22 per cent.) and slipping of the peroneal tendons in two patients.

Dr. D. A. Short [48], in discussing this paper, noted that an accurate diagnosis is frequently not made initially, the ankle being treated by closed methods. He also mentioned the difficulties encountered when the peroneus brevis tendon is too short.

Wednesday, October 7, 1953

Eosinophilic Granuloma of a Cervical Vertebra. Dr. H. B. Allison [46] reported the history of a patient in whom roentgenograms revealed total destruction of the seventh cervical vertebra, while a roentgenographic skeletal survey showed no other lesions. A biopsy was performed through the anterior triangle of the neck and by frozen section the specimen revealed eosinophilic granuloma. A full-thickness block of iliac bone was fitted into the defect, the bone graft being made wedge-shaped to prevent posterior displacement. Follow-up roentgenograms made nine months after the operation revealed osseous fusion from the sixth cervical vertebra to the first thoracic vertebra.

The Management of Primary Round-Cell Tumors of Bone. Dr. John H. Walker [47] and Dr. Hugh W. Jones [48] emphasized the importance of obtaining an adequate biopsy. Collaboration of the surgeon, pathologist, and radiologist was urged in the selection of the biopsy site. The excised tissue should include any extraosseous mass along with periosteum, cortical bone, and bone marrow. Frozen sections should not be considered reliable. The authors reviewed the results of irradiation therapy in a group of bone tumors treated at the Mason Clinic, Seattle, Washington, and found a high survival rate in patients diagnosed as having Ewing's tumor. Review of the slides resulted in three diagnoses being changed to reticulum-cell sarcoma and two diagnoses to solitary myeloma. The authors emphasized that:

1. In large centers where round-cell tumors have been critically re-evaluated, the diagnosis of Ewing's sarcoma has frequently been found to be erroneous;

2. Primary reticulum-cell sarcoma of bone deserves particular attention as a malignant, non-osteogenic round-cell tumor of bone which, though involving multiple bones and being anatomically inoperable, should receive aggressive rather than palliative irradiation;

3. Myelomata occurring as solitary tumors may closely resemble Ewing's tumor histologically.

The authors stressed that an attitude of pessimism concerning the management of bone tumors is not

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justified and that curative rather than palliative treatment should be undertaken in all cases of round-cell tumor of bone, even when more than one bone is involved. They cited patients with excellent results from intensive irradiation, even when there was a large tumor of an extremity with obviously enlarged regional lymph nodes. Treatment should include all areas of involvement and, if a primary tumor involves more than one bone, equal attention should be devoted to each lesion. A working diagnosis of round-cell sarcoma of bone in doubtful cases allows for an open mind in the prognosis and treatment.

Metabolic Studies of Skeletal Disorders. Dr. Robert D. Ray [49] presented two cases, one a white male, forty years old, with a diagnosis on admission of chondrodystrophia foetalis, the other an eight-year-old boy with a diagnosis on admission of osteochondrodystrophy. In both instances the serum calcium, phosphorus, and alkaline phosphatase levels were within normal limits. However, metabolic studies in the first patient revealed a disproportion between the urinary and fecal excretion of calcium and phosphorus and led to a diagnosis of osteomalacia. A daily dose of 300,000 units of vitamin D produced a positive calcium and phosphorus balance and reversed the ratio of urinary and fecal excretion of calcium and phosphorus. During convalescence from corrective osteotomies of the femur and tibia, a negative calcium and phosphorus balance resulted, necessitating discontinuance of vitamin D and calcium (given orally), since these increased the excretion of calcium in the urine. In the second patient, metabolic studies revealed a positive calcium and a negative phosphorus balance. No evidence of renal disease or of hyperparathyroidism could be found. The administration of 300,000 units of vitamin D a day improved the calcium balance without affecting the negative phosphorus balance. The basic pathological lesion was not identified in this patient. The author noted that these cases emphasize the importance of balance studies being made as adjuncts to surgical treatment in addition to the usual serum determinations of calcium, phosphorus, and alkaline phosphatase.

Bone and Joint Involvement in Coccidioidomycosis. Dr. Robert Mazet, Jr.[52], reported nineteen cases of coccidioidomycosis of bone and reviewed the literature, finding 118 cases. The disease is endemic in southwestern United States, northern Mexico, Venezuela, and a portion of Argentina. Isolated instances of the disease have been reported from almost all of the United States and from many foreign countries. The portal of entry is usually the respiratory tract and the initial symptoms during the primary phase are those of a mild upper-respiratory infection. Erythema nodosum or erythema multiforme is seen in about 20 per cent. of the cases.

Bone and joint involvement is rare and occurs during the secondary or disseminating phase which is found in only about 0.2 per cent. of affected persons. The secondary phase is more commonly seen in males. The mortality rate in white patients with disseminated lesions is approximately 50 per cent. In Filipinos and Negroes it is much higher.

The clinical manifestations and pathological reactions of the tissues are similar to those observed in tuberculosis. The diagnosis is established by the identification of the coccidioidomycosis spherules in the sputum, pus, or granuloma. The development of a positive reaction to a skin test or a rise of precipitin and complement-fixation titer are usually diagnostic.

Bone lesions in coccidioidomycosis simulate tuberculosis, are frequently multiple, and exhibit a predilection for bone prominences, such as the tibial tubercles, malleoli, patellae, trochanters, olecranons, and epicondyles. The involvement of practically all bones and joints has been reported. The lesions are usually associated with abscesses. There are no pathogenic or roentgenographic findings. No specific therapy is known.

Dr. Ruth Jackson [50], in discussion, considered Dr. Allison's treatment somewhat heroic, since roentgen therapy would have cured the lesion, although it would not have improved the mechanical derangement.

Concerning Dr. Walker's paper, she strongly emphasized the importance of adequate tissue removal for microscopic study, indicating that when possible, the entire lesion should be excised to permit study of cross sections of the whole tumor. Reticulum-cell sarcoma, in many instances, may be completely excised and the pathologist may predict whether the patient will be cured, depending on whether tumor cells are found in the blood channels or not. Metastasis from this type of tumor occurs by way of the blood channels and she questioned whether the lymph nodes were involved as stated by the authors.

Planigraphic Diagnosis of Osteomyelitic Sequestra. Dr. O. R. Walker [51] reviewed the literature on planigraphic roentgenographic techniques and presented the results of an investigation of twenty-two patients with chronic osteomyelitis of whom nine were found to have sequestra. The sequestra were localized accurately by means of this technique as shown by subsequent operation. The remarkable effectiveness of the planigraphic technique in revealing previously undisclosed sequestra was demonstrated in several patients with chronic osteomyelitis by roentgenograms made by the planigraphic techniques.

Primary Versus Secondary Tendon and Nerve Repair in the Forearm and Hand. Dr. John Ricker [52]

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presented a study of forty-eight patients with combined nerve and tendon injuries of the hand and forearm treated during the past four years. The patients ranged from eighteen months to seventy-six years of age. The causes of injury included gunshot wounds and automobile accidents with marked soft-tissue damage; many of the wounds were simple and cleanly incised. The structures involved were the main trunk or branches of the median or ulnar nerves, or both, and from one to twelve tendons. The final results varied according to the age of the patient, the severity of the trauma, and the location of the injury. The worst results occurred in injuries of the palm and in those involving multiple tendons and small nerve branches. In ten patients poor results were considered to be due to the following causes: poorly carried out primary treatment, infection, inadequate protection of repaired structures, and poor cooperation of the patient during the postoperative and rehabilitation period.

On the basis of this study and a review of the literature, the author outlined a program of treatment which included:

1. Careful clinical evaluation of the damage prior to surgery without wound probing;
2. Careful primary repair of all damaged structures if ideal conditions exist;
3. Simple wound closure only if conditions are not ideal;
4. Secondary repair carried out in three to six weeks when the tissues approach normal consistency and the joints are flexible.

Nerve sutures were protected for two to four weeks. Tendon repairs were protected for three to four weeks followed by carefully guarded active motion for an additional two weeks. Tendon repair is not usually successful later than two months after the injury, and grafting will be required. Nerves were repaired successfully up to three years following the injury.

Median Neuropathy at the Wrist. Dr. James N. Wilson [83] observed that at the wrist the median nerve passes through the rigid and unyielding osseofibrous carpal tunnel. Undue pressure upon the nerve in the carpal tunnel may result from extrinsic causes, such as fractures and dislocations of the carpus, or from intrinsic causes, such as acute or chronic tenosynovitis of the flexor tendons, peri-articular swelling following carpal fractures, a hematoma within the tunnel, thrombosis of an aberrant median artery, villonodular tenosynovitis, and non-specific tenosynovitis following digital flexor-tendon grafts.

Treatment in most cases has consisted in excision of the transverse carpal ligament in order to decompress the contents of the canal. In acute tenosynovitis, immobilization of the wrist in neutral position may prove beneficial. Long-standing injuries with a fusiform pseudoneuroma at the proximal edge of the ligament appear to do better without endoneurolysis.

Lumbar Adhesive Arachnoiditis. Dr. James Y. Phillips [84] stated that adhesive arachnoiditis is one of the more serious complications resulting either from the herniation of a nucleus pulposus itself or from the surgical management of this condition. It is usually an aseptic inflammation caused in all probability by pressure, but occasionally it is bacterial in origin. When associated with a ruptured disc, the usual causes of pressure found by the author have been protrusion of the disc with concomitant oedema and hemorrhage occurring at the time of rupture, injury to the dura and underlying structures, a projecting bone fragment after fusion, excessive bleeding at operation requiring the extensive use of hemostatic agents under pressure, injudicious use of cautery, and bacterial infection with abscess formation. The ultimate result depends upon the severity of the initial trauma, the amount of pressure developed, and the rapidity with which the pressure is reduced and the circulation of the spinal fluid is restored. If seen early, there is little or no spinal fluid and the nerve roots are swollen and are beginning to become adherent. Later, extensive scar tissue involves the whole intradural space as well as the dura and the epidural space. It is almost impossible to identify the roots under these circumstances. This complication should be suspected if after surgery symptoms develop of cauda equina compression or of an intervertebral-space infection. Under these circumstances immediate re-exploration is probably indicated in an attempt to relieve pressure. The dura in the majority of patients should be opened to determine the status of the circulation of spinal fluid and to break up early adhesions by the bathing of the roots in saline solution. In late patients with extensive arachnoiditis, surgical treatment is less successful. An attempt should be made to re-establish the circulation of spinal fluid by adequate decompression, lysis of the nerve roots, and release of the constricting band of scar with the dura left open. A foraminotomy should also be performed. Final results of such procedures may not be apparent for several months. Occasionally, when severe pain persists, especially if it is unilateral, cordotomy is helpful. In concluding, the author stressed the importance of the prevention of this condition by the proper selection of cases and good surgical judgment. He expressed the opinion that in some patients when search for the disc resulted in extensive hemorrhage and traction of the roots, results would be better if a simple posterior decompression were performed and the disc rupture were not found.

In the discussion of this paper, Dr. Gerald G. Gill [1] stated that the subject was most timely, since the diagnosis is frequently not made until numerous explorations with poor results have been performed. In many instances of extradural and nerve-root adhesions improvement may be obtained with straight-leg

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raising or toe-touching exercises. Epidural injections of weak procaine solution, followed by manipulation, may also be of help. In some instances, deep x-ray therapy or surgical exploration must be carried out. He pointed out that this paper emphasizes that during operation coagulation of normal nerve tissue and dura must be avoided, as well as rough and prolonged retraction of the roots and dura. Furthermore, massive protrusions should be diagnosed and decompression should be done early.

Congenital Indifference to Pain. Dr. John R. Black [56] in a review of the literature found eleven previously reported cases of this unusual condition and added seven new ones with the presumptive diagnosis of congenital indifference to pain.

An early manifestation of the syndrome occurs when the baby bites its tongue until it bleeds. Later, cuts, burns, and infections are common. In childhood, unusual injuries to growing bones and epiphyses develop which later take on the appearance of Charcot's joints. Five of the patients reported by the author belonged to one family; this is the first reported instance of a familial tendency.

Two patients studied at autopsy revealed no gross or microscopic abnormalities to account for the defect in pain perception. It is important to make an early diagnosis since by special care and alertness to the onset of illness in these children it may be possible to prevent serious complications. Of the seven patients reported, four died of acute infections.

In discussing this paper, Dr. G. Mosser Taylor [56] pointed out that this is the largest number of cases of the condition reported by any one author. The etiology is obscure, both the threshold to pain and its relation to age and psychological factors bear some relationship to it. A similar situation may be produced by prefrontal lobotomy, after which, although pain is not abolished, the patient accepts pain lightly or even humorously.

Dr. E. G. Chuinard [57] questioned whether the condition represents an absence of the organs of pain perception or a distorted pain perception resulting in pleasure from self-inflicted pain. The consistent finding of a subnormal mentality is probably a factor in this condition.

THE NORTH CAROLINA ORTHOPAEDIC ASSOCIATION

The Eighth Annual Meeting of the North Carolina Orthopaedic Association was held on September 12 and 13 at Wrightsville Beach, North Carolina, under the presidency of Dr. Lenox D. Baker. The meeting had been arranged and was conducted by the Association's amiable host, Dr. William J. Wilson of Wilmington, North Carolina. One can hardly imagine a more delightful gathering socially or a more stimulating meeting clinically. The official guests of the Association were Dr. C. B. Kendall and Col. C. H. Warren of Raleigh, North Carolina, and Dr. William A. Rogers of Boston, Massachusetts.

The Clinical Session was held on Saturday morning, September 12, 1953. Following a few words of greeting to members and guests by Dr. Wilson and the cordial welcome by Dr. Paul Black, President of the Hanover County Medical Society, Dr. George Holmes conducted the meeting at which a number of unusual cases were presented. Each presentation was followed by a lively discussion. Among these were three cases presented by Dr. Frank Forsyth [1]: one, a four-year-old boy, with an area of rarefaction, one by one and a half centimeters, in the upper femoral metaphysis which was revealed on biopsy to be aseptic necrosis; one, a four-year-old girl, who had been found at operation to have chronic osteomyelitis of the distal end of the ulna; and one, a young girl, who disclosed at operation a lesion of the upper portion of the pubic ramus characteristic of fibrous dysplasia.

Dr. W. J. Wilson [2] presented two cases of Legg-Perthes disease. These induced considerable discussion which led to a thorough-going review of the whole subject of treatment of this condition to which Dr. Harry Winkler [3] and Dr. W. A. Boyd [4] largely contributed. A third patient, one with aseptic necrosis of the femoral head, also provoked a discussion. A Vitallium-mold arthroplasty had been done which prompted several to express the view prevalent among the members that this form of arthroplasty had not proved to be so satisfactory when practised on North Carolinians as it seemed to be when performed on New Englanders. Dr. Hugh Thompson [5] pointed out that the person who had had a Vitallium-mold arthroplasty or in whom a femoral-head prosthesis had been inserted did not have a normal hip and must plan on restricted activity.

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[2] 11 South Third Street, Wilmington, North Carolina.
[3] 121 West Seventh Street, Charlotte 2, North Carolina.
[4] 1524 Pickens Street, Columbia 1, South Carolina.
[5] 309 Hillsboro Street, Raleigh, North Carolina.

Dr. R. B. Raney [6] presented two cases of hip pain secondary to the Otto type of pelvis. One of these occurred in a student of the University of North Carolina in whom roentgenograms revealed minimal changes. His symptoms had been relieved by traction applied at night. The other case was in a woman, sixty-five years old. Roentgenograms revealed extensive changes, and her symptoms were severe. She had been considerably relieved by injections of hydrocortone into both hips, by physical therapy, and by traction. Dr. Raney also presented a case of osteopetrosis in a child in whom roentgenograms showed classical changes.

Dr. Cabell Young, Jr.[7], presented a case of a girl, two and a half years old, who had been brought to him because of a rather striking deformity of the shoulder girdle. On examination, it was found that the deformity had been produced by congenital pseudarthrosis of the clavicle with sharp angulation at the fracture site. This was treated by resection of the fracture site and cancellous-bone grafting. The alignment was maintained by fixation with an intramedullary nail for four weeks, at which time intramedullary fixation was removed. Non-union persisted, but the child was asymptomatic and the deformity had not recurred. No further procedure was contemplated, unless with the child's growth it became necessary. Dr. Young also presented a case of a crack fracture of the middle third of the tibia with resulting non-union in a child, two and a half years old. The changes as seen by roentgenograms were similar to those seen in congenital pseudarthrosis. Both the child and the child's mother had multiple *café au lait* spots. Biopsy material taken from the fracture site showed only fibrous tissue. An onlay bone graft fixed with metallic screws had been inserted; but, after several months, union was still doubtful. Dr. George Miller [8] discussed the results of the treatment of this difficult condition at the North Carolina Orthopaedic Hospital, and the conclusions which they had been able to draw from their cases. Dr. Miller presented his own and Dr. William Roberts' [9] views on this matter. They feel that, if grafting is done, no fixation of the graft to the tibia should be employed. However, they feel that the most satisfactory method of treatment is by wide excision of bone and soft tissue, the use of intramedullary fixation, and bone-grafting.

Dr. Hugh Thompson [8] briefly discussed the use of pantalar fusion in certain selected cases of paralysis of the lower extremity. He described the technique which he and Dr. Walter Hunt [10] used. In his series of forty-two patients, only three pseudarthroses developed, these being at the ankle joint. In each patient the extremity was completely flail. Dr. Thompson felt that the pseudarthrosis was due to distraction and could have been prevented by the insertion of a pin through the upper end of the tibia, the pin being incorporated in the cast. He described his technique of completely removing the talus and denuding it of cartilage from the adjacent joint surfaces. Dr. Hunt stated that he had used the procedure four times in adults with excellent results, but that union takes appreciably longer in adults, about seven months as compared with four months in children. Dr. Thompson feels that the procedure is not used as often as it should be in children with flail feet.

Dr. George Miller [8] presented a case of an adult with low-back pain radiating down the left lower extremity to the foot as the result of an injury. The patient had a history of having been treated for syphilis many years before. Examination of the back was negative; laboratory studies contributed nothing; and the serological examination was negative. Dr. Miller had seen this patient after he had recovered from pain in his back and extremity, because of changes noted on routine roentgenographic examination of his back. Roentgenograms showed a mild spondylolisthesis of the fifth lumbar vertebra. A striking change was the almost complete destruction of the first lumbar vertebra and partial destruction of the twelfth thoracic vertebra. The lesion in the body of the first lumbar vertebra appeared to be an eroding lesion of the anterior portion of the body, while the lesion of the twelfth thoracic vertebra was an eroding lesion of the anterior portion of the body. This was thought to be due to an abdominal aneurysm. The destruction of the body of the first lumbar vertebra showed some bone fragmentation around the edges and was thought to be due to a Charcot spine. All members were not in agreement with this diagnosis.

Dr. H. R. Brashear, Jr.,[11] presented a case of pain in the upper portion of the back in a man seventy-four years old. Roentgenograms showed a destructive lesion of the third and fourth thoracic vertebrae, and on examination there was found a pulsating mass in this region. Laboratory studies gave no significant information. The patient did, however, have some blood in his urine. Aspiration was done unsuccessfully. Biopsy was carefully performed and at exploration it was found that the patient had a metastasis from a hypernephroma.

Dr. Ira Rapp [12] presented a case of Milkman's syndrome in a girl eighteen years old with multiple pseudofractures. Resection of some of these lesions revealed marked decalcification of the bone on each side of the pseudofractures. This has not been described as a common occurrence.

Dr. Walter Hunt [10] showed a broken Eicher prosthesis.

The meeting then adjourned to the Cape Fear Club of Wilmington for luncheon.

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[8] North Carolina Orthopaedic Hospital, Gastonia, North Carolina.
[9] 263 West Main Street, Gastonia, North Carolina.
[10] 309 Hillsboro Street, Raleigh, North Carolina.
[11] University of North Carolina School of Medicine, Chapel Hill, North Carolina
[12] 1922 Beverly Drive, Charlotte, North Carolina.

After luncheon, the official guest of the Association, Dr. William A. Rogers, Editor of *The Journal of Bone and Joint Surgery*, gave a short talk on various phases of publication of *The Journal*. In his talk, he traced a scientific paper presented for publication on its complete journey from the time it arrived at the office until it was published in *The Journal*. The mechanics of publication, the business of operation, and the hopes for the future of *The Journal* were outlined. Dr. Rogers then answered questions from the floor pertaining to these matters. The Clinical Session adjourned.

The following officers were elected for the ensuing year:

President: Dr. Julian E. Jacobs;

Vice-President: Dr. Everett I. Bugg, Jr.;

Secretary-Treasurer: Dr. George Holmes.

Winston-Salem was selected as the place for the 1954 meeting; the arrangements were placed in charge of Dr. Frank Forsyth and Dr. George Holmes.

SOCIEDAD LATINO-AMERICANA DE ORTOPEDIA Y TRAUMATOLOGÍA SOCIEDADE BRASILEIRA DE ORTOPEDIA E TRAUMATOLOGIA

Joint Meeting

The Second Meeting of the Sociedad Latino-Americana de Ortopedia y Traumatología, under the presidency of Prof. José Luiz Bado, and the Tenth Meeting of the Sociedade Brasileira de Ortopedia e Traumatologia, whose president is Dr. Oswaldo Pinheiro Campos, were held jointly in Petropolis, Rio de Janeiro, and São Paulo, July 18 to 28, 1953.

Besides the large representation of orthopaedic surgeons from all of the Latin American Countries, there were present as guests and visitors many famous orthopaedic surgeons from other countries. Among these were Dr. A. DeForest Smith (United States of America), Prof. Francesco Delitala (Italy), Dr. F. S. Glenn (United States of America), Dr. G. Küntscher (Germany), Dr. Harold Boyd, President of The American Academy of Orthopaedic Surgeons (United States of America), Dr. Harry Winkler (United States of America), Dr. J. Judet (France), Dr. J. R. Cobb (United States of America), Prof. Joseph Trueta (England), Prof. Lorenz Böhler (Austria), Dr. M. B. Ansart (Spain), Prof. Max Lange (Germany), Sir Reginald Watson-Jones (England), Prof. R. Merle d'Aubigné (France), Prof. Sten Friberg (Sweden), and Dr. Sterling Bunnell (United States of America).

Over 200 papers were presented in short communications. The Meeting was highly successful, not only scientifically but also socially.

Prof. Bado (Uruguay) acted as President of the Sociedad Latino-Americana de Ortopedia y Traumatología. Dr. Oswaldo Pinheiro Campos was President of the Meeting as well as of the Sociedade Brasileira de Ortopedia e Traumatologia.

Among the subjects presented together with the participating speakers were the following:

The Problem of Social and Functional Rehabilitation of the Disabled. Its Different Aspects.
Dr. J. O. Tesone (Argentina), Dr. E. Navajas Filho (Brazil), Dr. R. C. Bomfim (Brazil), Dr. J. I. Tarafa (Cuba), Dr. Juan Farril (Mexico), and Prof. José Bado (Uruguay).

Intramedullary Nailing of Fractures of the Long Bones. Indications, Technique, and Late Results.
Dr. I. C. Odena (Argentina), Dr. F. P. Camargo (Brazil), Dr. M. R. Santellices (Chile), Dr. H. R. Risco (Cuba), Dr. E. Alcivar (Ecuador), Dr. E. C. Toral (Ecuador), Dr. A. V. Zimbrón (Mexico), Dr. R. F. Olmedo (Paraguay), Dr. J. Colmenare (Venezuela), and Dr. J. Yanez (Venezuela).

Wrist Fractures Including Fractures of the Carpal Bones.
Dr. E. S. C. Batalha (Brazil), Dr. E. T. Carvalho (Brazil), and Dr. J. H. B. Faria (Brazil).

Spine Fusion. Technique and Indications.
Dr. D. Define (Brazil) and Dr. J. E. Kanan (Brazil).

Symposia

Reticulo-Endothelioma—Ewing's Sarcoma.
Dr. Fritz Schajowicz (Argentina), Dr. G. Elejalde (Brazil), and Dr. D. B. Brian (Argentina).

Fracture of the Os Calcis.
Dr. O. Marottoli (Argentina), Dr. T. Gebauer (Chile), Dr. A. G. Garcia (Cuba), and Dr. J. Figarella (Venezuela).

Metallic and Acrylic Prostheses in Hip Arthroplasties. Indications, Technique, and Late Results.
Dr. F. E. Godoy Moreira (Brazil), Dr. A. V. Zimbrón (Mexico), Prof. José Bado (Uruguay), Dr. Harry Winkler (United States of America).

Scoliosis.
Dr. L. A. Gonzales (Argentina) and Dr. E. C. Toral (Ecuador).

Instructional Courses

The Treatment of Paralytic Sequelae Involving the Hip and Knee.
Dr. E. Comodi (Argentina), Dr. Juan Farril (Mexico), and Dr. R. Caritat (Uruguay).

The Treatment of Paralytic Sequelae Involving the Foot.
Dr. A. Salvatti (Argentina), Dr. Oswaldo Pinheiro Campos (Brazil), Dr. R. Costa (Brazil), Dr. I. Pascan (Cuba), and Dr. G. V. Polo (Mexico).

Endocrine and Metabolic Bone Diseases.
Dr. N. Bloise (Argentina).

In Rio de Janeiro many visits were paid to several orthopaedic clinics and official receptions were given by Dr. Getulio Vargas, President of the Republic, by the Foreign Minister, and by the Rector of the University of Brazil.

The last three days of the Congress were held in São Paulo. The ceremony officially opening the Clínica Ortopédica e Traumatológica, the new orthopaedic hospital of the University of São Paulo, took place on July 31, 1953. Present were the Governor of the State and representatives of twenty-two other countries. After the ceremony, clinical cases were presented, anatomicopathological specimens were shown, and interesting roentgenograms were exhibited. A complete tour of the building was made during which visitors had an opportunity to see all of the activities of the Hospital, including the new orthopaedic workshop.

Many surgical demonstrations were conducted in the modern operating theater of the Clínica Ortopédica e Traumatológica by Dr. Harold Boyd, Prof. Max Lauge, Dr. Sterling Bunnell, and the Staff of the Hospital.

There followed a visit to Pavilhão Fernandinho Simonsen, at Santa Casa, where clinical cases were presented and surgical demonstrations were prepared for the visitors.

The following subjects were discussed in São Paulo by a number of illustrious orthopaedic surgeons.

Modern Treatment of Bone and Joint Tuberculosis. Indications, Technique, and Late Results.
Dr. Carlos E. Ottolenghi (Argentina), Dr. J. A. Estrada (Bolivia), Dr. Orlando P. Souza (Brazil), Dr. Alberto Veloso Novoa (Chile), Dr. Augusto Bonilha (Ecuador), Dr. Domingo Vasques Rolfi (Uruguay), and Dr. H. Cortes Mujica (Venezuela).

The Treatment of Several Types of Fractures of the Upper Extremity in the Child.
Dr. Luiz A. Tesone (Argentina), Dr. R. S. Ramos (Brazil), and Dr. A. Inostroza (Chile).

Recurrent Dislocation of the Shoulder.
Dr. H. Lago (Argentina), Dr. A. Feria (Cuba), Dr. R. F. Rojas (Mexico), Dr. José J. Domingues (Mexico), and Dr. Alberto Croquevielle (Chile).

Fractures of the Upper Third of the Humerus.
Dr. Carlos Arquiri (Argentina), Dr. Fernando A. Garcia (Bolivia), Dr. José P. M. Souza (Brazil), Dr. Orlando P. Nunez (Chile), and Dr. Herbert Cagnoli (Uruguay).

A visit was paid to the hospital Santa Casa de Misericórdia in Santos.

After the Congress a course on scoliosis was given by Dr. J. R. Cobb in the Clínica Ortopédica e Traumatológica, the service of Prof. Dr. F. E. Godoy Moreira.

The President of the New Board of Directors of the Sociedad Latino-Americana de Ortopedia y Traumatología is Dr. Juan Farril (Mexico) and the President of the 1955 Meeting, to be held in Mexico, is Dr. A. Z. Zimbrón.

AMERICAN COLLEGE OF SURGEONS: THE FORUM ON FUNDAMENTAL SURGICAL PROBLEMS

Orthopaedic Section

The Forum on Fundamental Surgical Problems relating to orthopaedic surgery of the Thirty-ninth Clinical Congress of the American College of Surgeons was held in Chicago, Illinois, on Wednesday, October 7, 1953. Established in 1941, the Forum has proved to be one of the most interesting and valuable features of the Congress. A separate forum is devoted to each of the major divisions of general surgery. The popularity of the Orthopaedic Section of the Forum was attested this year by the large attendance; the program, presided over by Dr. J. Albert Key, proved to be especially stimulating. Summaries of the papers presented follow:

Histochemical Studies in Bone Disease: I. Distribution of Acid and Alkaline Phosphatase in Bone Tumors as a Diagnostic Aid. Dr. W. S. Gilmer[1] noted that several benign tumors, particularly non-osteogenic fibroma, solitary bone cysts, osteogenic fibroma, and fibrous dysplasia, may be mislabeled as giant-cell tumors. By the use of the modified technique of Gomöri to show the presence of acid phosphatase and of alkaline phosphatase in tissue sections, a better differentiation of these tumors can be made. Giant-cell tumors contain no alkaline phosphatase. Acid phosphatase is found in both the giant cells and stroma

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cells; it is not present in any of the four tumors which may be mistaken for giant-cell tumors as previously mentioned. Conversely, alkaline phosphatase, not present in giant-cell tumors, was present in the stroma cells of the four lesions previously mentioned, and the giant cells of these lesions might contain acid phosphatase. Neither enzyme was found in fibrosarcoma. He reported that alkaline phosphatase was present but no acid phosphatase was present in osteogenic sarcoma. Alkaline phosphatase without acid phosphatase may be present in sections from metastatic carcinomata, with the exception of osteoblastic prostatic carcinoma in which acid phosphatase is present.

It was brought out in discussion by Dr. J. Albert Key [2] and Dr. R. T. Odell [3] that the special staining technique employed requires fresh tissue fixed in alcohol or acetone, not in formalin, and requires the decalcification of thin sections of tissue in buffered citrate. Consequently, it cannot be used in routinely fixed tissue.

The Effect of Compound F upon Experimental Arthritis in Rabbits. Dr. R. H. Ramsey [4] and Dr. J. Albert Key [2] reported that inflammation was produced in both knees of twenty-two adult rabbits. One knee of each rabbit was treated by weekly injections of hydrocortisone acetate, while the other served as a control. In half of the animals, a small amount of India ink was injected with the irritant. In one group of rabbits, two cubic centimeters of a 10 per cent. suspension of oil of turpentine in water was injected into each knee, and in the other group a 10 per cent. suspension of talc in water was injected. Treatment with hydrocortisone acetate was begun forty-eight hours after the injection of the irritant, and consisted in the injection of 2.5 milligrams or 7.5 milligrams into the right knee at weekly intervals. The animals were sacrificed at intervals from eight to fifty-eight days after the injection of the irritant.

In both series, on gross examination, the control knees exhibited a variable degree of inflammation with injection of blood vessels and reddening and thickening of the synovial membrane. Similar changes were present in the treated knees, but in most instances they were less in degree. Some of the treated knees were nearly normal in appearance. The knees in which India ink had been injected were stained brown or black.

On microscopic examination, the synovial tissues exhibited a variable degree of inflammation with proliferation of the synovial cells and infiltration of the subsynovial tissues by mononuclear phagocytes and small round cells. Moreover, the intensity of the reaction was less in the treated knees. This was especially noticeable in the older lesions produced by talc. Here the talc aggregates were adherent to the synovial surface and were being extruded from the joint by the formation of a new synovial surface on the granuloma. Such granulomata were less cellular in the treated joints. No difference was noted between the knees which were treated with 2.5 milligrams of hydrocortisone and those which were treated with 7.5 milligrams of hydrocortisone.

In these joints the inflammatory process was well under way before treatment was started. The hydrocortisone acetate lessened the further progress of the inflammation and the treated joints tended to return to a more normal condition than did the control joints.

Experimental Use of Iproniazid in the Treatment of Resistant Non-Tuberculous Infections of Bone. A Preliminary Report. Dr. David M. Bosworth [5] and Dr. J. William Fielding [6], following rather extensive use of iproniazid and some remarkable results from its use in patients with resistant cases of bone and joint tuberculosis, many with secondary infections, had used the drug in a smaller series of patients with non-tuberculous infection of bone. This was done because secondary infections in many of the patients with tuberculosis treated with iproniazid showed marked improvement as well. The effect of the drug was such as to produce a fall in temperature, relief of pain, vasodilatation, diminution and often cessation of sinus drainage, weight gain, euphoria, and a rather marked osteoporosis. Necrotic pieces of bone were not involved in the decalcification, while surrounding bone and involucrum became rarefied. This caused sequestra to stand out markedly in bone in roentgenograms, so that their removal could be planned and carried out. This was termed "washing out of bone", and it had been found that this occurred after about twelve weeks of use of the drug.

It was pointed out that, while the drug is still available for experimental investigation only, physicians who desire to use it in patients may request a supply from the manufacturer in return for a report of the case and follow-up information on the patient.

Slides were shown, demonstrating the dramatic improvement in several patients with chronically draining sinuses of osteomyelitis, which had previously proved resistant to extensive treatment by generally accepted methods.

The dosage given was four milligrams per kilogram of body weight per day—to be started at three

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[6] Sea View Hospital, Staten Island 14, New York.

milligrams per kilogram and to be increased to the point of euphoria. Two patients had received the drug for ten months without untoward results, except for euphoria.

The drug appears to be a potent chemotherapeutic aid in the treatment of osteomyelitis, in severe cases, resistant to presently employed antibiotics and may permit successful surgery in such cases.

Dr. Daniel Yancey [7] asked if there was any effect of the drug on peripheral nerves. Dr. Bosworth stated that there is an effect and that studies have shown a higher concentration of the drug in the spinal fluid than in the blood stream.

A Study of the Effect of Pressure on the Healing of Bone. A Preliminary Report. Dr. Lee T. Ford [8] and Dr. J. Albert Key [9] pointed out that controversy still exists as to whether or not positive pressure is an aid in the healing of defects in bone. While the authors employ positive pressure in arthrodesis of the knee joint, they wonder whether it is the pressure or the more perfect immobilization or both which favorably influences union.

Twenty operations were carried out on nineteen dogs, in which multiple transverse cuts were made in the crest of the ilium. By means of small nails and small rubber bands, one of the cuts in each dog was subjected to heavy pressure, another was subjected to light pressure, another was used as a control, and a cut between the cuts subjected to pressure was opened and was held in distraction by means of bone blocks on either side of this cut being shifted slightly by the pressure forces. Some degree of infection occurred in ten of the nineteen dogs, but this did not seem to interfere significantly with healing. Both the control and the cuts subjected to pressure healed rapidly. By three weeks, all of the cuts had been healed by firm trabeculae of bone. The cut held in distraction healed slowest, the V-shaped defect being filled in from the bottom. The application of pressure did not seem to accelerate or to retard the healing of bone.

The authors concluded that bone which is largely cancellous and which has a good blood supply will unite readily when immobilized in good apposition. In these experiments the addition of positive pressure did not seem to have any marked influence on the rate or the manner in which healing occurred.

Irradiation of Bone in the Presence of Intramedullary Metallic Fixation. A Preliminary Report. Dr. Jack Wickstrom [9], Dr. Robert H. Hutchinson [10], Dr. Edward T. Haslem [11], and Dr. J. V. Schlosser [12] noted that many roentgenologists who treat cancer have cautioned against the use of x-ray therapy to parts which have been the site of fracture fixed by metal, and particularly by intramedullary nailing which is now used extensively in the treatment of pathological fractures. Such treatment was objected to on the ground that the metal would shield parts of the tumor from the radiation, and also that secondary radiation would result from the metal and would cause bone necrosis.

To study the problem experimentally, the authors operated upon a series of dogs, producing in each a bilateral fracture of the ulna by osteotomy. This was fixed on one side by means of a Steinmann pin (three thirty-seconds of an inch). The other ulna was used as a control and the fracture sites were each exposed to 2,000 to 4,000 roentgens. Prior to exposure to the x-ray, a "mock-up" made of masonite was placed over the limb to simulate the scattering effect of the x-rays by soft tissue. Later the fractures were examined grossly and microscopically for healing. The fractures treated by pinning showed a slight lag in healing. Microscopically not much difference in the two sides was noted except that the irradiated bone stained more deeply than the non-irradiated bone. Destruction of marrow by the nail was noted.

The authors' conclusion is that x-ray therapy has no deleterious effect on the healing of fractures fixed by intramedullary nails and is not contra-indicated when such treatment is anticipated.

In the discussion which followed, it was stated that at one center in Minnesota pathological fractures due to metastatic carcinoma are treated with x-ray irradiation prior to treatment of the fracture by internal fixation.

Changes in Bone Following Exposure to Ultrasonic Energy. Dr. N. I. Ardan, Jr.[13], Dr. Joseph Janes [14], and Dr. J. F. Herrick [15] reported their experimental studies of ultrasonic energy. Sixteen dogs were operated upon and the shaft of the femur was exposed bilaterally. Each femur was directly exposed to ultrasonic sound by use of a stationary technique and 15 watts at 1000 kilocycles and 20 watts at 800 kilocycles. Three exposures of five minutes each were given with five-minute intervals for cooling. Local rise in temperature in the bone of from 11 to 30 degrees centigrade occurred. On several dogs similar exposures were made over the femur by "blind technique". In the soft tissues of the dogs over the point of exit of the waves necrosis often

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[11] Tulane University School of Medicine, New Orleans, Louisiana.
[12] Tulane University School of Medicine, New Orleans, Louisiana.
[13] Mayo Clinic, Rochester, Minnesota.
[14] 102-110 Second Avenue, S.W., Rochester, Minnesota.
[15] Mayo Clinic, Rochester, Minnesota.

developed. Oedema and paralysis of the entire limb developed in one dog. The sound waves produced liquefaction of fat.

The effect on the bone was variable. Several dogs showed marked necrosis of cortical bone, with periosteal new-bone formation. A pathological fracture occurred in one femur. All dogs, including those with negative roentgenograms, showed at autopsy brownish discoloration of the treated bone. Three femora were examined microscopically; these showed total necrosis of the bone in the treated areas.

In conclusion the authors stated that, while the effect of ultrasonic energy is variable, it can produce necrosis of bone. Any stationary technique in which the medium is used is potentially dangerous.

Strength of Intervertebral Discs. Dr. F. Gaynor Evans [16] and Mr. Herbert R. Lissner [17] reported on the progress of investigative work done for the United States Air Force in the study of the mechanism of injuries to pilots using ejection seats. The static vertical loading effect on intervertebral discs was studied on cadavera. Eleven cadavera were used, ten white and one Negro. Eight were embalmed and three were unembalmed. The pelvis, sacrum, and lumbar spine were dissected out and vertical loading applied. A special machine which gradually applied a load was used. Discograms were done and roentgenograms of the specimens with weight applied were made. An average vertical weight of approximately 700 pounds produced maximum change in shape of the disc but no rupture. Weights varying from 610 to 970 pounds were used to obtain maximum deflection. Above these weights crushing of the bone occurred.

Spines were tested forcefully by use of different apparatus which bent them in various directions. Extreme forward bending was found to produce rupture of the fourth lumbar disc or the third lumbar disc.

The Use of Radio-Active Phosphorus in the Determination of the Viability of the Femoral Head in Dogs after Subcapital Fractures. Dr. E. Bruce Tovee [18] and Dr. Edward Gendron [19] reported that, in a series of 150 dogs, operations were done in which subcapital fractures of the femur were produced, thus cutting off the entire blood supply to the head. The head was then repositioned and fixed with a lag screw. Radio-active phosphorus was used to study the return of the circulation in the head of the femur. Following injection of the chemical, the upper end of the femur was removed for chemical determination and microscopic section.

It was found by microscopic studies that the head was dead nine days after the fracture and that the fracture then healed and the head was revascularized in from three to six months. In the average dog with a well reduced and well nailed fracture, clinical healing was complete at four weeks. The use of a Geiger counter for the detection of concentrations of radio-active phosphorus in various portions of the head and neck of the femur showed that there was essentially no circulation in either the center or the cortex of the head.

In dogs with well reduced fractures, well fixed by the screw, concentrations of radio-active phosphorus in the head were essentially the same as those in the neck of the femur after six months. This indicated that the ingress of blood supply to the head was adequate. It was found that cartilage on the head of the femur, even when the head was dead, took up some of the isotopes from the joint fluid.

In illustration, tissue sections showing the ingrowth of fibrous tissue, blood vessels, and new bone into the necrotic femoral head were projected.

The authors believe that poor results from aseptic necrosis in fractures of the neck of the femur are due to inaccurate reduction, poor nailing, or too early weight-bearing.

They propose the use of a small sterile Geiger counter, capable of being inserted along the nail tract of a healed femoral neck after the removal of the nail, hoping by the aid of radio-active isotopes to be able to gauge the status of circulation in the head and neck.

THE JAPANESE SOCIETY OF ORTHOPAEDIC SURGERY

The Twenty-sixth Annual Meeting of the Japanese Society of Orthopaedic Surgery was held at Kyushu University in Fukuoka on April 8, 9, and 10, 1953, under the Presidency of Dr. Tamikazu Amako.

The scientific program included 127 presentations. The following are summaries of some of these:

Investigation of Küntscher's Intramedullary Nailing in the Treatment of Fractures. Dr. Seikei Miyagi [1]. In Küntscher's intramedullary nailing, there is wide destruction of bone marrow, there is a large foreign body left in the bone, and there is a question of whether fracture healing and the general condition of the patient are not adversely affected.

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[18] 170 St. George Street, Toronto 5, Ontario, Canada.
[19] Toronto, Ontario, Canada.
[1] Kurume, Japan.

Dr. Miyagi had reviewed 180 consecutive patients so treated in the Department of Orthopaedic Surgery of Kyushu University and Kurume Medical College. He had also experimentally investigated the process of fracture healing and the behavior of bone marrow following intramedullary nailing.

His conclusions regarding the healing of the fracture are briefly as follows:

Dr. Miyagi examined roentgenographically and histologically the process of fracture healing in rabbit tibiae from three days to twelve weeks after intramedullary nailing. He found that healing did not differ in any way from that in the natural course. He believes that the scanty bridging callus found shows histologically the effect of firm fixation. He also noted that (1) ossification of the cortical callus when the intramedullary nail had been left in the bone marrow was retarded in the first week; but, after this short time, the uniting callus and the anchoring callus formed excessively; (2) nickel and chromium were detected in the soft tissues surrounding the nail (18-8 SMo) but were not recovered from the callus; and (3) intramedullary nailing did not inhibit contact compression of the fragments and did seem to accelerate bony union. The transparent shadow which sometimes appears in the roentgenograms in the callus and which indicates slight movement of the fragments, especially from shearing force, was noted in these rabbits.

In clinical cases of femoral fracture, obscure cloudlike callus appeared roentgenographically in one month and became sharp at the borders three to four months after intramedullary nailing. The fracture line was visible for more than six months after intramedullary nailing. The characteristics of the callus were changed quantitatively and qualitatively by such various factors as the severity of the lesion, the local condition, the operative method, and the mechanical conditions.

Regarding the behavior of the bone marrow, Dr. Miyagi said that the products of the bleeding and necrosis in the bone marrow, following the insertion of the nail, were absorbed and that there was quick regeneration. Fibrous membrane was formed around the nail in three to four weeks, and the bone marrow was perfectly regenerated in four weeks. Regeneration of the bone marrow after the extraction of the nail was complete in eight weeks.

Although the majority of the nutrient arteries of the rabbit tibiae were injured by the V-shaped nail, some of the arteries remained unimpaired, having been thrust away to one side of the bone marrow. Small arteries were regenerated from those remaining and spread to the fracture site. As seen in venograms, after an opaque substance had been injected along the nail or into the hole left by the extracted nail, the venous system of the bone marrow was separated into two parts at the fracture site, although the venous circulation of the bone marrow proper was not disturbed.

Body temperature, liver function, and hemograms were not different from the findings after other operative methods in the treatment of fractures.

Muscle atrophy of one to 1.5 centimeters appeared in the thigh in about one half of the patients with femoral fracture in about six months. Through the use of the integration method of myography, it was confirmed that the power of the quadriceps usually reached normal strength within six months after the insertion of the nail.

The average range of motion at the knee joint was 90 degrees of flexion in three months after the insertion of the nail.

The operative recommendations of Dr. Miyagi follow: The open insertion of the nail is preferred. It is important to adduct the proximal fragment of the femur maximally when retrograde insertion of the nail has been selected. When a curved nail has to be inserted, the nail should be straightened before it is inserted into the other fragment. The nail chosen is not necessarily so long that it reaches the spongiosa of the other fragment—it is sufficient that the nail penetrate eight to ten centimeters past the fracture site. As far as the width of the nail is concerned, Dr. Miyagi selects one somewhat smaller in diameter than the diameter of the medullary cavity. When such a nail is used, it fixes the fragments at several of the inner surfaces of the cortex in the manner described by Rush.

Complications were as follows: The postoperative blood-plasma fat level, determined according to Bloor's method, was 25 per cent. higher than the preoperative level in five to fifteen minutes after the insertion of the nail. It then decreased slowly in twenty-four hours to the preoperative level. In other operative procedures used in the treatment of femoral fracture, the blood-plasma fat level reached 20 per cent. Although the author had encountered no instance of fat embolism, he emphasized the avoidance of shocking manipulation and advised caution in the presence of cardiac disorders and in the treatment of elderly patients. Among other complications, there were eight cases of migration of the nail, seven cases of bending of the nail, seven cases of non-union, and one case of infection.

On Twins with Congenital Dislocation of the Hip. Dr. Hiroshi Kambara [2] and Dr. Yônosuke Sasakawa [3] reported, in 1949, a portion of the results from a genetic study of congenital dislocation of the hip in eleven pairs of twins, pointing out that far more instances were necessary to verify the significance of dislocation in twins from the standpoint of etiology. During the subsequent four years, seven more pairs of twins were observed, bringing the total number examined to eighteen pairs of twins (eleven pairs: monochorionic; six

[2] Niigata, Japan.

[3] Niigata, Japan.

pairs: biovular; and one pair of unknown ovular origin). In the meantime seven other pairs of twins were found and were reported elsewhere in Japan.

The total number of affected pairs of twins so far reported in Japan (a country in which the incidence of congenital dislocation of the hip is considered to be low) is thirty-six. The cases discovered in a simultaneous examination of 150 pairs of twins in Niigata-Shi numbered two (1.3 per cent.) (one pair: monochorionic; one pair: biovular). The disorder was found in 1.01 per cent. of infants who were not twins, so that there can be no great difference in its incidence between the two groups.

When the number of spontaneous recoveries from congenital dislocations are taken into account, the incidence among twins cannot be considered to be low.

Only thirty-one of the thirty-six pairs of twins with congenital dislocation of the hip reported in Japan have been examined thoroughly, the sexual and ovular differences being ascertained and the presence or absence of dysplasia being determined roentgenographically. Of the thirty-one pairs, sixteen pairs were female and monochorionic, six pairs were male and monochorionic, five pairs were female and biovular, and four pairs were male and biovular. Of the twenty-two monochorionic pairs, congenital dislocation was present in both twins in fifteen pairs and in only one twin in six pairs. [In this computation one pair of twins has not been accounted for.] Of the biovular pairs, three had congenital dislocation in both twins and six in one twin only. Idelberger has recently reported 137 similar cases. In his conclusion he states that the disorder is a disease of irregular dominant inheritance.

When it is judged statistically from the authors' cases and those reported elsewhere in Japan, the disease is shown to be an hereditary disease or an induced disease. Any qualitative explanation of the genesis of the disease by the law of twins is hardly possible beyond certain limits.

A Histochemical Study of the So-Called Umbauzone. Dr. Nahoto Takagishi [4] had tied together two parallel ribs of rabbits so as to create an *Umbauzone* bone (deposition zone) on each bone at the center of the binding and had then conducted histochemical studies of the polysaccharides. The sections were stained in three ways,—with Hochkiss's periodic acid (Schiff method), with a solution of toluidine blue (0.05 per cent.) at pH 2.5 or 7.0, and with a solution of methylene blue (0.03 per cent.) at pH 3.0.

The presence in the tissue sections of substances stainable in this low range of pH, which showed the phenomena of metachromasia, indicated the presence of acid mucopolysaccharides.

The metachromatic ground substances were found to decrease gradually in accordance with the degree of bone reaction. In bone which had become necrotic, the ground substances were greatly diminished or even completely absent. In the stage of bone deposition, however, the ground substances were seen gradually increasing, but on the last day of the experiment (twenty-seven weeks after the experiment was begun), they had not been completely recovered. It was found that chondroitin sulphate was contained in the hyaline cartilage.

The ground substance diminished with the progress of ossification.

The pH was near the optimal pH for akaline phosphatase.

Changes in the Femoral Neck in Legg-Perthes Disease. Dr. Atsuto Nishio [5] and Dr. Toru Matsumoto [6] pointed out that the histological study of Legg-Perthes disease has hitherto been confined to a description of the changes in the femoral head and a description of the processes of atrophy and repair without the formulation of an explanation of the etiology of the disease. Accordingly, current views of the cause of the disease are based upon mere assumptions.

Remarkable changes appear in roentgenograms of patients with Legg-Perthes disease in both the femoral head and the femoral neck. In view of these changes, findings in serial sections of the capital epiphysis and of the central portion of the femoral neck were examined microscopically and were compared with the roentgenograms. The study was made possible through the use of a newly devised tissue-extracting needle which is employed during the extra-articular transplantation of autogenous bone grafts.

In the roentgenograms, no remarkable changes were seen in the shadow of the femoral neck in 26 per cent. of the patients; a picture of atrophied bone, without any evidence of bone sclerosis around it, was found in 37 per cent.; and a picture of advanced bone atrophy with surrounding bone sclerosis was noted in 37 per cent. Histologically, the epiphysis of the femoral head was seen to be in a state of utter atrophy with no evidence of the beginning of repair; the bone cortex appeared resorbed in places, and in the neck a small portion of the cartilage had disappeared. Major changes were seen in the form of resorption of bone trabeculae in a portion near the epiphyseal cartilage of the metaphysis; primitive, dying, and disintegrated epiphyseal-cartilage cells were found here and there; cells similar in form to the hypertrophied cells of the epiphyseal cartilage were found scattered between the bone trabeculae of the neck; the bone marrow had been invaded by connective tissue; and the trabeculae were atrophied, necrotic, or resorbed. The cartilage was seen enveloped in connective tissue, unattended by any evidence of ossification; cartilage cells were arranged irregularly and some lacked a nucleus; and a small number of cells were, in many instances, seen in a large cartilage matrix. In one instance, disintegration in the epiphyseal-cartilage plate was seen with

[4] Fukuoka, Japan. [5] Fukuoka, Japan. [6] Fukuoka, Japan.

ossification going on here and there. Retrogression and degeneration, without loss of cell nuclei, were found in the articular cartilage. Where repair had been completed, there was seen here and there in the epiphysis connective tissue interspersed with restored trabeculae. The epiphyseal-cartilage plate, although still retained, appeared in many parts to have a more primitive structure and to have degenerated and become fibrotic. It was seen from these findings that the ischaemia of the epiphysis and the changes in the neck are characteristic of Legg-Perthes disease and that the loss of cartilage in the metaphyseal portion of the femoral neck is peculiarly characteristic of the disease. These changes are not to be seen in normal persons. The changes in Legg-Perthes disease, when they are considered in conjunction with the fact that the highest incidence of the disease occurs in persons about the age of seven, seem to indicate that some disturbance of the ossifying process may cause the disease.

A Study of Grafting with Freeze-Dried Bone Chips (Malleable Bone). Dr. Bunichiro Kawamura [7] reported that he had succeeded in 1951 in grafting freeze-dried bone chips (malleable bone) clinically and experimentally. He emphasized that the bone can be kept alive in a usable condition for a far longer period by means of this method than by any other. Freeze-dried bone can be transported easily (even by mail) in a simple package, and no concern need be given to temperature.

Malleable bone which had been mixed with a 25 per cent. solution of sodium alginate was used clinically with success in the majority of his cases of plastic bone-grafting.

Hardening of the graft mixture through the use of a 10 per cent. solution of calcium chloride was insufficient. Satisfactory hardening was not obtained by the use of a 10 per cent. solution of gelatin, but the use of a 40 or 50 per cent. solution of gelatin answered the purpose fairly well.

Mere compression was not enough to harden a sodium alginate bone mixture, or one of 10 per cent. solution of gelatin, satisfactorily. Hardening by high-frequency vacuum drying, as applied to malleable bone in sodium alginate, resulted in the desiccation of the peripheral portion but not of the central portions. When high-frequency vacuum drying was carried out and a hollow cylinder was used, the hardening of the bone mixture was not sufficient.

The transplantation of homogenous plastic bone, hardened with a 10 per cent. solution of calcium chloride, was used as a cortical graft to fill a bone defect, ten millimeters long and five millimeters wide and as deep as to be separable by the thickness of paper from the marrow cavity, produced on the ridge of the tibia in adult rabbits. The result was studied roentgenographically and histologically at regular intervals. At the end of the third week there were signs of osseous adhesion to the tibia, and repair work was progressing steadily.

A homogenous plastic bone graft which had been hardened in a 10 per cent. solution of calcium chloride was used to fill bone defects eight millimeters long in the radii of adult rabbits. The result was observed roentgenographically and histologically. In successful experiments, there was marked formation of callus at the end of the second week, there was bridging callus in three weeks, there was osseous union in four weeks, and there was good subsequent repair. In unsuccessful experiments, the malleable bone graft was completely absorbed, disappearing almost completely as seen by roentgenogram in nine or ten weeks. In almost all experiments, the cause of failure was suppuration.

Tests for serologic reaction were carried out, an antigen solution prepared from a mixture of the bone-graft preparation in physiological saline being used. The test was made once a week for five weeks after the transplantation. Serum of the patients with malleable bone grafts was added to the diluted antigen solution for the precipitation reaction, physiological saline solution being used as control. The response to the test was negative in all of the twenty-three patients tested. The results in fifty patients in whom the plastic bone graft mixture had been used in the treatment of delayed union, pseudarthrosis, arthrosis, and bone defects and as an adjunct in such procedures as arthrodesis, vertebral fixation, and osteotomy were not so satisfactory as with the use of fresh autogenous bone grafts; they were as good, however, as those obtained from the use of the refrigerated bone grafts which had been used in more than fifty patients at the author's clinic.

A Study of the Treatment of Fractures by Calcium-Alginate Intramedullary Nailing. Dr. Fujio Wakamatsu [8] and Dr. Kaoru Oikawa [9] reported the results of their study of calcium alginate as a means of intramedullary fixation in the treatment of fractures. The substance does not significantly affect a living organism and can be made fairly strong by processing.

Transverse fractures were produced artificially in the radii of rabbits, and nails made of 40 per cent. calcium alginate were inserted into the bone marrow. The absorption of the nail and the process of healing were studied roentgenographically and histologically at regular intervals.

The results obtained and the conclusions reached are as follows: A dynamic test of the stability of intramedullary nailing with a nail made of calcium alginate and a flexion test done with a fresh rabbit radius performed for the measurement of the strength, hardness, and maximal flexibility of the nail confirmed the authors' contention that the nail was sufficiently strong and hard for the purpose of fixation. It was demon-

[7] Sapporo, Japan. [8] Sapporo, Japan. [9] Sapporo, Japan.

strated in roentgenograms made a week after the insertion of the nail that the dislocation of fragments was slight as compared with that in the control. A roentgenographic examination disclosed that callus was produced relatively well. Periosteal callus was particularly marked in an area with the fracture as its center. The appearance of periosteal callus was most marked in three weeks; a uniformly dense spindle-shaped callus in the region of the fracture was seen in a complete form in the fourth week; the endosteal callus was recognizable as dots and lines, although it was not markedly shaded; the periosteal callus gradually shrank and became condensed in the fifth week, and was visible only as a slender shadow and was hardly distinguishable at the fracture site in the eighth week. No thinning of the cortex was detectable at any time during the whole course of the experiment.

The histological findings were as follows: In the first week, there was seen proliferation of osteogenic cells, as well as the marked formation of connective tissue and the production of granulation tissue. In the second week, the osteogenic cells were greatly increased, the fractured ends were joined by a connective-tissue weld, the surrounding original bone trabeculae were covered everywhere by newly deposited trabeculae, and cartilaginous osteoid tissue was barely visible. In the third week, a large increase in the amount of new bone was noted, as well as a large number of osteoclasts which were destroying and absorbing the existing cortex. The intramedullary nail was still present but was partially dissolved. It was covered everywhere with fibrous tissue, but there was very little cell reaction. In the fourth week, ossification was well advanced, and there was extensive formation of lamellae. Endosteal callus was gradually formed and the perforated portion was filled with connective tissue. In the fifth week, the fracture-fragment ends were firmly fused together and the union was ossified; the marrow cavity was enlarged; and the intramedullary nail was retained in the shape of a plank. In the eighth week, new bone trabeculae completed the fusion. The intramedullary nail was half absorbed but it was still recognizable.

In the controls with no intramedullary nailing, the fracture passed through a similar course of healing and complete ossification was recognizable in eight weeks. However, a remarkable increase of cartilaginous osteogenic cells at the fracture site was observed in the second, third, and fourth weeks.

The authors concluded that the experimental results demonstrate that calcium alginate is a reasonable, well absorbed, fixation material for use in the treatment of fractures.

A Study of the Use of Titanium in Orthopaedic Surgery. Dr. Hidekichi Wakamatsu [10], being interested in the attachment of titanium to bone, as well as in the determination of its strength and non-corrosiveness, had studied the biological reactions of titanium. The material used in his study was probably not free from impurities, because the metal is produced by the magnesium-reduction method. In x-ray permeability, approximately one millimeter of the metal equaled seven to eight millimeters of aluminum. A titanium plate five millimeters by ten millimeters by one millimeter was inserted into the subcutaneous tissue of a rabbit's back, and the reaction was observed. In the first week after its insertion, the plate was seen to be partially covered with an extremely thin coating of connective tissue, and in the second week and in the subsequent week the plate was completely covered with a layer of connective tissue. The coating of connective tissue grew in thickness until it ceased to grow and to change in size in the third week.

The reaction of titanium with bone was studied after the insertion of a titanium plate of the same size through a crack made in the ventral cortex of the femur deep into the bone marrow. In the tissues surrounding the plate, there was clotting of the hematoma on the second day; and a week later and during several subsequent weeks there appeared, confronting the plate and beyond the inmost layer of fibrin, a layer of connective tissue composed of spindle cells and collagenic cells and a third or outer layer of connective tissue, resembling bone undergoing regeneration with proliferation of bone trabeculae. The increase in trabeculae became more marked week by week, and the proliferation of osteoblasts was rapid in the periphery of the cortex until after the eighth week. Some of the newly formed cortex was thicker than the original, and the bone marrow was recognizably degenerated.

The attachment of titanium to the osseous elements was so strong that the plate was not easily removed in the fourth week, and the bone had to be partially broken in order to remove the plate in the sixth week. The weight of the plate was measured before and after insertion for comparison. There was 0.005 gram or less decrease in weight of the plate when it had been inserted into the subcutaneous tissue, and 0.001 to 0.005 gram or less decrease in weight when the titanium plate had been inserted into bone.

The examination of the blood and urine disclosed no particular changes.

The attachment of titanium to bone, which is so fast in the sixth week after its insertion as to be inseparable without the breaking of part of the bone, was examined under the microscope and was studied by means of mechanical measurement.

In the author's experiment, the reaction of titanium on bone was considerable, although this fact was not noted by Leventhal. The findings in the bone marrow reminded the author of chemical injury to this tissue, but there was no notable systemic change. Such local degeneration as was disclosed in these experiments may have been caused by the impurity of the titanium.

[10] Sendai, Japan.

A Study of the Muscle Functions Concerned in the Movement of the Ankle Joint. Dr. Naoichi Tsuyama [11], Dr. Ryôhei Suzuki [12], and Dr. Junichiro Otaka [13] examined electromyographically the muscle function of the lower limb concerned in the movements of the ankle joint in normal persons. The action potentials were obtained by means of a needle electrode. They found that:

1. The abductor hallucis gives a marked discharge in abduction of the great toe and a reflex discharge while the subject is standing;

2. The flexor digitorum brevis gives a reflex discharge when the center of gravity is shifted forward;

3. The extensor digitorum brevis gives a discharge in the extension of the toes and in the last stage of pronation and dorsiflexion of the ankle;

4. The abductor digiti quinti gives a discharge in abduction of the little toe and when either leg is in a standing posture;

5. When the subject is walking, the abductor digiti quinti is the first to discharge, the abductor hallucis is next, and the flexor digitorum brevis is the last;

6. The gastrocnemius participates in the movement of the ankle joint later than the peroneus longus when the movement is an extension of the ankle, and later than the tibialis anterior when the movement is supination of the ankle. The lateral head of the gastrocnemius begins to act later and more weakly than the peroneus in pronation of the ankle;

7. The quadriceps femoris participates in the last stage of dorsiflexion of the ankle when the knee is in an extended position, and the vastus medialis participates in the last stage of supination of the ankle.

The phase relations of these muscles were also examined.

A Study of Functional Conversion of Muscles Following Tendon Transplantation. Dr. Ryôhei Suzuki [12] presented his electromyographic findings in an experimental study of the functional conversion of transplanted muscles in poliomyelitis.

Transplantation of the semitendinosus to the patella in treatment of habitual dislocation of the patella and of paralysis of the femoral quadriceps, a sequel of poliomyelitis, was followed by conversion of muscle function for the latter but not for the former.

The long peroneal muscle was transplanted to the base of the first metatarsal in treatment of paralysis of the tibialis anterior, with a satisfactory result in all patients. Conversion of muscle function was demonstrable in the electromyogram within one year after the operation. The functional conversion was, however, less easily accomplished in patients in whom there existed function of the tibialis anterior than in those in whom that muscle was paralyzed. In one patient in whom the tibialis anterior was paralyzed, the functional conversion was readily demonstrable in the electromyogram immediately after the removal of the plaster-of-Paris dressing without any training exercises. In another patient, an infant too young to walk, a number of spikes in the electromyogram of the long peroneal were present every time the toes were flexed a year after the operation.

The tibialis posterior was transplanted to the dorsum of the foot in the treatment of paralytic equinus and varus deformity in eight patients, and functional conversion was demonstrable in two patients and not demonstrable in four, the remaining two being still under observation. The two patients in whose electromyograms spikes were shown, indicating the action of the transplanted muscle when the ankle joint was dorsiflexed, had complete paralysis of the extensor muscles. In these functional conversion was accomplished very soon,—immediately after the removal of the plaster-of-Paris cast in one. Of the four patients in whom no functional conversion was accomplished, one patient had general paralysis of the plantar muscles, another had a certain measure of paralysis of the transplanted tibialis posterior itself, and two others had paralysis of the tibialis anterior with the other extensor muscle unaffected. The remaining two patients, still under observation, have paralysis of the tibialis anterior alone, and no functional conversion is yet recognizable, presumably because the time after operation is not yet long enough.

The tendon of the extensor hallucis longus, cut in the middle, was transplanted to the base of the fifth metatarsal by its proximal portion and to the tendon of the extensor digitorum longus by the distal portion in the treatment of paralysis of the tibialis anterior. On the electromyogram, it was seen that the spikes from the action of the transplanted muscle gradually diminished as the toes were plantarflexed.

Patients in whom a muscle was shown to be working well preoperatively when examined electromyographically and found to fail postoperatively were re-operated upon. It was thus proved that the tonus of the muscle was insufficient. After re-operation, the spike discharges on the electromyogram were restored to the preoperative level. It is needless to say that there can be no functional muscle conversion in patients in whom there is insufficient tonus.

Presumably the functional conversion of a transplanted muscle originates in the brain. The author transplanted antagonistic muscles in three cats in an attempt to solve the problem. Four to six months after the operation, when the animals were considered to have regained normal walking power and the muscles were considered to have completed their functional conversion, the brain was removed from each so that

[11] Tokyo, Japan. [12] Tokyo, Japan. [13] Tokyo, Japan.

its influence might be cut off. The appearance of the electromyographic spikes of the transplanted muscles during tonic neck reflex showed no change ascribable to the transplantation.

It was concluded, therefore, that:

1. An antagonistic muscle transplanted to the non-paralyzed side can hardly induce any functional conversion;

2. Functional conversion occurs more readily in the long peroneal muscle than in the tibialis anterior;

3. Once the functional conversion has been started, the original function begins to be discarded gradually;

4. Insufficiency of tonus in transplanted muscles is detectable in electromyograms. No functional conversion can occur in patients with insufficient tonus;

5. The center of the functional conversion appears to be located in the brain.

A Study of the Temperature of a Joint. Dr. Yutaka Sakaida [14] and Dr. Kiyoko Iida [15] reported their clinical study of the temperature of knee joints as a diagnostic aid. The measurement of the temperature of knee joints was made twenty-six times in seventeen males and sixteen times in eight females. These included three patients with rheumatoid arthritis, one with rheumatic fever, seven with osteo-arthritis, three with traumatic arthritis, four with arthralgia, three who had been immobilized in plaster-of-Paris, one with tuberculous arthritis, one with intermittent arthritis, one with hemiplegia, and one normal patient.

After skin sterilization, a Bier needle was thrust into the bursa suprapatellaris. A thermocouple of 0.2 copper-constantan was inserted for thermometry immediately after the withdrawal of the stilette. Determinations were made every five minutes. Twenty to thirty minutes after the introduction of the Bier needle, an exploring needle was thrust into each joint space from the opposite side, and thirty to forty cubic centimeters of warm or cold physiological saline solution was infused in an equal quantity into each joint by means of a Nishimaki injector. The consequent rising or falling rate of the temperature was examined. Intra-articular injection of hydrocortone was tried. The skin temperature was measured in the prepatellar region.

The temperature measured within five minutes of the insertion of the thermocouple was higher in the affected joint than in the unaffected joint, averaging 35.34 degrees centigrade in the former and 33.69 degrees centigrade in the latter. When the temperature was measured twenty to thirty minutes afterward, the temperature was higher than it was initially in both joints, averaging 37.73 degrees centigrade in the affected joint and 34.26 degrees centigrade in the unaffected joint. The atmospheric temperature was kept as constant as was possible and averaged 19.3 degrees centigrade plus or minus 2 degrees. The humidity was kept at the average of 69.62 per cent. plus or minus 10 per cent. When it was measured under these conditions, the skin temperature was higher in the affected joint than in the unaffected joint in practically all patients, averaging 32.0 degrees centigrade in the affected joint and 30.4 degrees centigrade in the unaffected joint. On the average the skin temperature was lower than the joint temperature in the initial stage by 3.34 degrees centigrade in the affected joint and by 3.24 degrees centigrade in the unaffected joint.

The stability of the internal pressure, which presumably constitutes an important factor, is still under investigation. Observations made without taking this factor into consideration showed that, after the infusion of cold water, the temperature curve normally declined sharply for the first ten minutes and then declined gradually. The fall seemed to be more gradual and to take a longer time to become stabilized in the affected joint than in the unaffected joint. The skin temperature began to rise five minutes or so after the infusion of water, reached a peak in ten minutes, and declined later. Warm-water infusion was not done in a sufficiently large number of patients for any reliable result to be obtained.

On the Popularization of the Arthroscope. Dr. Seiki Watanabe [16] and Dr. Sakae Takeda [17], calling attention to arthroscopy, pointed out the excellence of an arthroscope recently devised by Takaki. This arthroscope has several optical tubes of varying size, is equipped with a camera, and has a biopsy needle.

The authors have been routinely using the arthroscope for diagnosing tuberculous arthritis of the knee in its early stage and various other diseases and traumata of the joints.

The special features of the arthroscope which the authors describe are that it can be used in the examination of the knee joint in both children and adults, that it is relatively free from imperfections and is fit for prolonged use, that it has a wide field of vision, and that the locality under inspection can be easily identified. The entire visible portion of the anterior chamber of the knee joint can be examined when necessary in one operation. The instrument is equipped with two or three such devices as hooks and scissors which can be inserted into the joint. Thus, while this arthroscope is somewhat inferior in precision, it is well adapted for general use.

Electrophoretic Study of Proteins in Joint Fluid. Dr. Hisashi Komiyama [18] examined the proteins

[14] Tokyo, Japan. [15] Tokyo, Japan. [16] Tokyo, Japan.
[17] Tokyo, Japan. [18] Yonago, Japan.

in the joint fluid from eighty-six patients with various forms of arthritis by means of electrophoresis. He found, using a pH of 8.0 and a phosphate buffer of 0.16 micron, that synovial fluids contained five electrophoretically well defined components. One of the components is an acid polysaccharide, hyaluronic acid. The other four components have the same mobility as that of albumin and the three globulin fractions in serum protein.

The protein components of joint fluid in acute joint inflammation show a decrease in albumin, an increase in total globulin, a proportional rise of the α globulin over the β globulin, and a slight to marked increase in γ globulin, in proportion to the severity of the inflammation. In chronic arthritis, the joint fluid shows, as a rule, a moderate increase of total globulin, but keeps a normal albumin to globulin ratio. The γ globulin is responsible for the major portion of the total globulin increment.

The time relationship of the proportional rise of the α globulin over the β globulin in the joint fluid appears to be relatively slower than with plasma components.

The marked increase of γ globulin in the joint fluid suggests the possibility of a local production of proteins or enhanced tissue breakdown and suggests that the condition of the joint fluid can be said to have the character of pus.

A comparative study of the proteins of joint fluid and the proteins of plasma reveals that there is no substantial difference between the two from the point of view of differential diagnosis. What difference exists is valuable in the judging of the clinical course and prognosis of certain forms of arthritis.

The influence of joint fluid upon the plasma-protein fraction is significantly correlated to the total globulin, especially to the γ globulin fraction.

Albumin and γ globulin in the joint fluid are not correlated to the sedimentation rate.

Hyaluronic acid can be determined electrophoretically in quality but not in quantity from the standpoint of the differential diagnosis of the various forms of arthritis.

Experimental Studies of the Extracorporeal Culture of Human Skin. Dr. Teuro Nakashima [19] had cut off a sterile piece of normal skin in such a way that it was equal in thickness to the papillae of the corium retained in it. The piece of skin was then kept in a sterile Ringer solution. It was cut into smaller pieces, as nearly one square millimeter in size as possible. Each of these pieces was separately cultured, with five to seven pieces comprising one group. For the culture medium, autoplasma was used; this was taken early in the morning when the stomach was empty. The culture was done in an incubator at 37 degrees centigrade by means of the cover-glass method. Two hundred thousand units of penicillin G potassium was diluted with physiological saline solution to bring the concentration down to an appropriate degree. This was then dripped into and mixed with the plasma medium in the quantitative ratio of 0.5 to 1. Physiological saline solution alone was added to the plasma as a control.

The relation between temperature and preservability was studied in this experiment. Pieces of skin, approximately 0.5 to one centimeter square, were kept in sterile Ringer solution for a certain period of time. Some were kept at low temperature (0 degrees to 4 degrees centigrade), some were kept at room temperature (17 degrees to 20 degrees centigrade), and others were kept at high temperature (37 degrees centigrade) before cultivation. The control was put under cultivation within three to four hours after excision. The specimens were cultured in the same medium for five days. The result was that proliferation of groups of epithelial cells and connective-tissue cells (mainly the former) was seen on the cut surface of the tissue and around it.

Penicillin was moderately inhibitory to cultivation in 10,000 units per cubic centimeter and slightly inhibitory in 1,000 units per cubic centimeter. It was slightly accelerative in 100 units per cubic centimeter or less. Penicillin promoted greater growth in low concentrations than in high concentrations during the early days, but, even in areas in which the drug was in a high concentration, growth was promoted because the penicillin was broken down and the concentration was made optimal.

These facts indicated that penicillin has no considerable toxic action on the growth of human epithelial tissue, but that it disturbs the growth of tissue in high concentrations. Penicillin promotes growth slightly in 100 units per cubic centimeter, more vigorously in 10 units per cubic centimeter, and most vigorously in 1 to 0.1 units per cubic centimeter.

The experiments on temperature and preservability disclosed that growth in twenty-four hours was inhibited to a slightly greater degree than it was in the control. Toward the low temperatures in declining order, the experiments indicated that in forty-eight hours the inhibition was generally of moderate degree at three different temperature levels, although it was stronger at higher temperatures and weaker in slightly declining order at the lower temperatures; that in seventy-two hours the growth was inhibited to a marked degree at low temperatures, and that growth was stopped altogether at high temperatures. It is clear from this result that, in a specimen of preserved skin, growth is inhibited more and more with the lapse of time, that growth is relatively resistant to low temperature, and that growth is disturbed most seriously at high temperature.

Agglutination of Tubercle Bacilli by Means of Sensitized Kaolin Particles in Patients with Bone and Joint

[19] Nagasaki, Japan.

Tuberculosis. Dr. Daiji Kashiwagi [20], Dr. Masaaki Shimizu [21], and Dr. Jenzaburo Yamamoto [22] reported in 1952 part of the results of their study of the agglutination of tubercle bacilli by the use of kaolin as an antigen, sensitized by polysaccharides and broken by lipoids. To one cubic centimeter of kaolin suspension they added four cubic centimeters of a 10 per cent. solution of polysaccharides. The mixture was kept in a water bath for one hour and then was centrifuged at 1,000 revolutions for ten minutes. The supernatant fluid was poured off, and the precipitate which was added to five cubic centimeters of lipoid solution was thoroughly shaken and was kept in a water bath at 37 degrees centigrade. The liquid thus obtained was used as an antigen solution to cause the reaction. The serum of the patient to be examined was previously inactivated by keeping it at a temperature of 56 degrees centigrade for thirty minutes. It was then diluted with twice its volume of physiological saline at a pH of 7.0 to 7.2. The diluted serum was divided into two fractions, to each of which was added 0.5 cubic centimeter of the antigen solution. The mixture was kept in an incubator at 37 degrees centigrade for one hour; it was centrifuged at 1,000 revolutions for five minutes; and the result was determined.

By this method the agglutination of tubercle bacilli was measured in the serum of rabbits which had been inoculated with living and dead tubercle bacilli.

They found that the production of the agglutination was observable in one to two weeks in rabbits which had been inoculated with Aoyama B strain of the human type of tubercle bacilli.

In rabbits inoculated once a week with ten milligrams per kilogram of body weight of the Aoyama B strain which had been killed by heating and drying, they found a relatively rapid and large increase in the agglutinin titer. A sudden rise in the agglutinin after re-inoculation in two groups, one inoculated with dead bacilli and the other with living bacilli, was presumably ascribable to the effect of the previous infection.

The reaction was next induced in normal persons with bone and joint tuberculosis, in people having a positive Wassermann reaction, and in patients with rheumatoid arthritis. The result was compared with that of the Middlebrook-Dubos reaction. The reaction was also studied in 152 patients, including sixty-nine with tuberculous diseases, eight with rheumatoid arthritis, twenty-two with a positive response to the serum test for syphilis, and seventeen with other diseases. The kaolin reaction was positive in sixty-six (95.6 per cent.) of the sixty-nine tuberculous patients and negative in three, of whom two were clinically regarded as cured. The Middlebrook-Dubos reaction, on the contrary, was positive in forty-three (78.2 per cent.)—a lower percentage than that for the kaolin reaction—of fifty-five tuberculous patients. The two reactions were each positive in one of eight patients with rheumatoid arthritis in whom the sedimentation rate was considerably increased. The agglutinin titer was low in either reaction, and neither proved positive in any condition. The kaolin reaction was positive in one of twenty-two patients having a positive response to the serum test for syphilis. The response was positive in only two of seventeen patients with non-tuberculous diseases of the bones and joints (in these tuberculosis was suspected), but the agglutinin titer was low in both patients, and neither had a positive reaction in subsequent tests. The Middlebrook-Dubos reaction was positive in one of thirteen patients, but the reaction became negative later on as in the kaolin reaction, indicating that the patient was not tuberculous.

Of thirty-six normal persons, three gave positive kaolin reactions; and of twenty-three normal persons, three gave positive Middlebrook-Dubos reactions. Preoperative and postoperative periodical observations of eleven patients undergoing surgical operations for tuberculosis of bones or joints disclosed that the agglutinin level rose markedly after operation in all patients, fell by degrees in patients with a favorable prognosis, and rose abruptly in patients with relapse. The temporary rise in agglutinin titer, occasionally induced in postoperative patients permitted to bear weight, is inexplicable without further studies in a greater number of patients.

In conclusion, the authors stated that the agglutination reaction described seems specific for tuberculous diseases. The rate of positive reactions was higher (95.6 per cent.) for the kaolin reaction than for the Middlebrook-Dubos reaction (78.2 per cent.). This reaction is parallel to the sedimentation rate to some extent, but the latter is not specific for tuberculosis. The tuberculin reaction and this reaction appear to have some relation between them as regards their respective strength. An operation for tuberculosis of bones or joints and weight-bearing on the affected extremity are followed by a temporary rise in the agglutinin titer produced. A sudden rise in its level during the postoperative course must be taken to indicate the probability of relapse.

The level of the agglutinin is higher in active tuberculosis than in the non-active state. This reaction is significant in the differential diagnosis of tuberculosis.

Articular Arthrodesis Combined with Focal Débridement for Tuberculosis of the Hip Joint in Juveniles. Dr. Sachu Konô [23] and Dr. Toshio Kitagawa [24] have used arthrodesis combined with focal débridement at the sacrifice of mobility in children in order to promote healing, to prevent relapse, to restore quickly and permanently the capacity to bear weight, to allow painless walking, to prevent shortening and contracture, and to hasten the development of compensatory function.

[20] Yonago, Japan.
[21] Yonago, Japan.
[22] Yonago, Japan.
[23] Niigata, Japan.
[24] Niigata, Japan.

Concerning shortening and the occurrence of contracture, the authors said that, when the lower limbs are shortened by ten centimeters or more as frequently happens in the treatment of tuberculosis of the hip joint in juveniles, the result is a serious functional disturbance. The authors have investigated the relation between the state of osseous destruction and the method and duration of fixation, and also the relation of the degree of bone destruction and the disturbance of growth to age. They have followed roentgenographically the fate of the lower femoral epiphysis and of the epiphyseal cartilage of the upper end of the tibia. They found that, in cases of complete fixation in children, the narrowing and other abnormalities of the epiphyseal-cartilage plate and its replacement by bone trabeculae, particularly from its central and posterior portions, began in one year or so. They also found that, in cases of fixation of four or five years' duration, the closing of the epiphyseal cartilage and the deformity of the epiphysis were recognizable early in the period of growth (at the age of ten or so) and that the shortening of the affected extremity goes on, even if the patient is permitted later on to walk, bearing weight on the affected part. Further, it was seen that in patients with complete knee-joint fixation of two years' duration for Perthes' disease in whom the non-weight-bearing long brace was used, there occurred practically no shortening of the limb, nor were there found any changes in the roentgenograms. The facts indicate that complete fixation in recumbency constitutes the greatest factor in the bringing about of a serious change in the proximal epiphyseal cartilage of the knee joint. It is, therefore, conceivable that the chief requisites for the prevention of shortening of the lower extremity would be reduction of the pathologically dislocated limb, replacement of bone-deficient areas, the greatest possible reduction in the duration of fixation, and early weight-bearing.

The appearance of contracture in an affected hip joint is, as Futamura says, a condition almost invariably present in young patients in whom the disease is accompanied by bone destruction. It is hardly possible to prevent such contracture and to preserve the joint. On the other hand, extra-articular arthrodesis, performed without the reduction of the dislocation, is not infrequently followed by contracture due to muscle action on the displaced femur. It seems reasonable, therefore, that arthrodesis should be effected after the displaced femur has been restored to its normal position and after the antagonistic muscles have been placed in such a position as to maintain balance.

The authors have employed arthrodesis combined with focal débridement with good results. When it is done before the appearance of fibrous adhesions, it makes possible the elimination of foci and the reduction of the dislocation. A bone defect can be filled with bone grafts, and early bony union is made possible by the building of a bridge from the ilium to the femur with a relatively large piece of bone. This will allow the removal of knee-joint fixation and permit the patient to walk with a brace in six to ten months in adults and in eight to twelve months in children. The disturbance of growth is thereby held to the minimum and the subsequent appearance of contracture is decreased in frequency by the preservation of the epiphyseal cartilage plate proximal to the knee joint.

In juveniles, stiffness in the hip joint due to arthrodesis is compensated for by such functional changes as an increased range of movement on the unaffected side, and an excessively increased mobility of the lumbar vertebrae and of the lumbosacral joint. The compensatory functional changes are brought about more extensively the younger the patient is, and more markedly in cases of complete osseous rigidity, than in any other articular disorder. Accordingly, a tuberculous hip joint stiffened in its functioning position does not much inconvenience the daily life of the young patient.

Experiences with Late Spinal-Cord Injuries. Dr. S. Mizuno[25], Dr. M. Kaibara[26], Dr. T. Imoto[27], Dr. S. Kasai[28], Dr. T. Huzisita[29], and Dr. S. Omura[30] had studied twenty-three patients with late spinal-cord injury and twenty-four patients with bladder disturbance of other etiology, including the malignant diseases. The patients usually had severe cystitis with more or less diminished bladder capacity, and the urine was badly infected. Calculi were found in one half of the patients. Muscle atrophy of an advanced degree was often combined with severe decubital ulcers; there was one death due to irrecoverable hypoproteinaemia several weeks after admission.

An improved design of tidal drainage was advocated which made possible unobstructed starting and ending of the syphonage, and complete evacuation of the bladder. The system seemed easier for untrained personnel to attend to and more reliable.

Each step in the current urological as well as neurosurgical management, including posterior rhizotomy, has been found to be effective when properly used. The authors do not, however, agree with Meirowsky and others in the dissection of the anterior as well as of the posterior nerve roots, over a rather wide area, and do not approve of intrathecal alcohol injection, repeated exploration of the cord, and unrestricted use of transurethral resection.

Bladder training may be successfully carried out even after three and one half to eight years if the patients are cooperative. There are cases which strongly suggest the existence of "dormant nerve fibers" as Kabert points out; there are patients in whom sensory as well as motor recovery was seen after several years.

[25] Ôsaka, Japan.
[26] Ôsaka, Japan.
[27] Ôsaka, Japan.
[28] Ôsaka, Japan.
[29] Ôsaka, Japan.
[30] Ôsaka, Japan.

SYMPOSIUM ON LOW-BACK PAIN

A Study of the Mechanism of Low-Back Pain. The Neurohistological Examination of the Disease. Dr. Chu Ikari [21] described his neurohistological examination of low-back pain. Various tissues were examined in the region extending from the level of the first lumbar vertebra to the level of the fifth lumbar vertebra and from the skin of this area to the anterior walls of the vertebrae, including the skin, fascia, muscles, periosteum of the vertebral bodies, ligaments, intervertebral cartilage, and posterior articular capsules. The actual condition of the terminal portion of the sensory nerves and the vegetative nerves found in the area were studied by means of Seto's silver-impregnation method. These inquiries resulted in the acquisition of some basic data on the subject which may be summarized as follows: The tissues first examined were those in the distribution of the posterior rami of the lumbar cord. In the skin, the papillae were found to contain a few sensory-nerve elements which generally terminated in a simple structure, that is, either non-ramifying or forked; the nerves in contact with hair papillae were ill developed and terminated in a simple and undersized structure (either plexiform or serrated). However, in skin with the ordinary amount of hair there was found, although not previously reported, a non-encapsulated and complicated ball-of-thread-like nerve termination in the anterior wall and in the papillary layer of the corium. Vegetative nerves with a terminal reticulum were seen well developed in the papillary layer. The fascia in this region was supplied with neither sensory-nerve elements nor vegetative nerves. Sensory-nerve terminals in the lumbar muscles appeared to end in muscle spindles. The sensory-nerve terminations in the muscle spindles were found to be classifiable according to type.

Transformation from muscle to tendon was not infrequently observed in this region, but no tendon spindle has yet been found. Nor have there been found Golgi's bodies or any simple non-ramified nerve terminals. Only Vater-Pacini's bodies were found to be well developed in the rough connective tissue between muscles where the posterior ramus passes slightly forward after leaving the intervertebral foramen. Some scattered vegetative nerves were seen with a terminal reticulum between the sheaths of the fibrillar bundles of each muscle.

The tissues in the distribution of the dural rami and the anterior rami of the lumbar nerves were also examined. The iliopsoas contains more nerve elements than any other muscle—the ilioinguinalis nerve, the genitofemoralis nerve, and other large nerves. Other nerves are found between the iliopsoas and the vertebrae and form two lumbosacral plexuses. These, along with the sympathetic trunk, are located in the anterior wall of the vertebral body. The reticular type of nerve ending which is found in this muscle is similar to that in any of the muscles described in the foregoing. The periosteum of the vertebral body abounds in nerve elements and well developed nerve terminals. The terminal is divisible in type into the simple non-ramified form, the complicated plexiform type, and the encapsulated ball-of-thread-like body. The last-mentioned form, although not yet reported, has been found in various stages of development. Vater's bodies, noted by Dauber, have not been found by the author. What was noted, however, was that control by the vegetative nerves prevails here, with Stöhr's reticular terminals scattered here and there between collagenic fibers. Transition from the anterior longitudinal ligament to the vertebral periosteum is indistinct, but nerve elements are recognizable here also. The presence of nerve elements in the annulus fibrosus was not observed by the author in normal adults, nor was a blood capillary observed between vertebrae. The distribution of vegetative nerves observed in the cartilaginous vertebrae of the embryo and newborn makes one presume that these nerves participate in the ossification of these bones. The author has found some vegetative-nerve fibers and Peterson has found some medullated nerve fibers in the bone marrow of adults, but no nerve terminal has ever been found there.

In the joint capsule of the posterior articulations, the transition from synovial membrane to flaval ligament is similar to that from the menisci to the synovial membrane and capsule of the knee joint, although the former is on a much smaller scale, and is accomplished with very little participation by the nerve elements.

Pathological Physiology in Low-Back Pain. Dr. Isaharu Miki [22] and Dr. Naoki Morisaki [23] investigated the pathogenesis of low-back pain by means of the injection of novocain locally. The site was identified by the relieving of the pain with novocain and by the intensifying of pain with hypertonic saline solution. The pain was classified according to location, and in most cases it was described as heavy and oppressive or as a feeling of tension. The similarity of the pain felt during the infusion of the saline solution to that caused by obstructed blood flow in the forearm from the tight binding of the arm led to an understanding of a part of the underlying mechanism.

There are relatively few reports available on pain in muscles, in ligaments, in bones, and in joints, although there are many reports on the mechanism of pain in other tissues, as in skin areas and in the viscera. The authors had investigated muscle pain by causing it experimentally and had analyzed pain due to obstructed blood flow. Muscle pain could not be induced by acetylcholine or histamine, but was produced readily by the injection of a solution of 6 per cent. saline. Electromyography was used to ascertain muscle activity

[21] Sendai, Japan. [22] Tokyo, Japan. [23] Tokyo, Japan.

as a pain reflex, and it was found that the injection of hypertonic saline caused no spontaneous discharge. However, reflex extensor muscle-contraction discharge was observed in most patients with lumbago when the back was bent forward by external force. This may be taken as evidence of slight inflexibility. Muscle contraction occurring with deep-seated pain is to be seen in the form of an extensor reflex, a form less intensive than that of spontaneous discharge. They feel that, anatomically, pain due to spondylosis deformans, spondylolysis, or spondylolisthesis may be understood to be located mainly in such soft tissues as portions of the ligaments and tendons, although it must of course be admitted, as Yamamoto has pointed out, that there is in bone a pain-producing mechanism resulting from increased internal pressure due to congestion. Articular synovial membranes are generally little subject to pain; they are utterly free from pain during and after injection of acetylcholine or histamine. Joint capsules are prone to ache, and even the injection of histamine causes pain in these capsules. They do not ache when distended by saline, although a pinching pain may be felt in some portions.

Muscle and Fascia in Low-Back Pain. Dr. Takefumi Morotomi[34] had attempted to classify lumbar myalgia. He had found that the difficulty of the study lay in the anatomical complexity of the region, the multiplex nature of the pathological picture, and the scarcity of objective symptoms.

The author had studied the disease in a large number of patients finding that it is most frequently contracted in the working years of life by the laboring population. Some sufferers had previously had "rheumatism", but many had not. Many complained of some dental disease. The onset was of an acute nature in most patients and treatment effected cure in the majority of cases. In the rest a chronic condition developed. In some, however, the condition was chronic from the start. The local pain was often felt in the region lateral to the transverse process of the third lumbar vertebra, and a point of tenderness was identified variously in the lumbar region. The pain was found on one side of the spine in most patients, and pain was found on both sides and at several points not infrequently. Initially, there was an extensive muscle induration which could be easily felt, but in patients with chronic disease it was barely tangible. The pain accompanying bodily movement was characteristically increased on forward bending of the body and was not felt at all on backward bending. In the acute stage, scoliosis was often due to involuntary muscle spasm, the convexity being toward the unaffected side. Characteristically this was increased when the body was bent forward, and it disappeared when the body was in the prone position. The skin was insensitive over an area corresponding to the indurated portion of the muscle.

As seen in roentgenograms, the spinal column was unaffected in all but a few patients.

Autopsies were performed by the author with a view to the determination of the condition of the softer parts, particularly with reference to the peripheral-nerve distribution and the relation of the fascia and nerves. In ninety-five cadavera it was demonstrated that the dorsal branches of the spinal nerves were not uniformly supported all along their way from their origin to the skin; they were strongly supported in some portions and weakly in others. The manner of their penetration through the fascia is of four types. It was seen that the dorsal branches thickly ramified and intertwined irregularly on the dorsal side of the fascia of the lumbar spinal muscles. In the region in which the pain was frequently induced, the exit of the nerve from the sacrospinal muscle and its exit from the lumbodorsal fascia were in greater proximity than in any other part. It was also confirmed that in the embryo and during surgical operations the lumbodorsal fascia is under greatest tension when the two upper extremities are stretched upward and the back is bent forward.

Macroscopic observations were made during operation, and tissue specimens obtained at operation were examined histologically. Perivascular infiltration gradually changing to scar formation was observed in patients with sudden onset, and mere cicatrix and occasionally tubercles that were seemingly dry were found in patients in whom the disease was chronic from the start.

Sensory tests, electromyography, and, in a few cases, skin-temperature measurements had been carried out. The site of diminished sensation was identifiable by means of Minor's reaction and the electromyogram revealed the signs of fibrillation. In patients with no other symptom than pressure pain, Minor's reaction gave no reliable response, nor was there seen any sign of fibrillation.

In the lumbar fascia and the accompanying connective tissue, a number of dorsal branches of the spinal nerves were found particularly in the vicinity of the transverse process of the third lumbar vertebra. The nerves were so located as to be easily compressed by the fascia when the body was bent forward, so that it seemed that any lesion occurring in the fascia and the accompanying connective tissue might easily stimulate the nerve and induce the pain. It was also conceivable that the consequent disturbance of blood flow in the area might bring about some chemical change.

Low-Back Pain as It Is Seen in Relation to the Intervertebral Foramen. Dr. Isao Aoike[35] pointed out that, seen from the standpoint of local anatomy, there is little cause for wonder that changes in the intervertebral foramen should cause pain to be referred to the low back and lower extremity. Anatomical, physiological, and pathological knowledge of the basic facts of the foramen is deplorably scanty and the participation of

[34] Hirosaki, Japan. [35] Tokyo, Japan.

the foramen in the causation of low-back pain and pain referred to the lower extremity is only vaguely presumed from this insufficient knowledge. The foramina were studied mainly in the lumbar region by the dissection of anatomical specimens and clinically in patients with spondylolysis, spondylolisthesis, and with fused vertebrae in tuberculosis of the spine. Measurements were made of the internal pressure of the subarachnoid cavity in patients with backache.

Changes in the intervertebral foramen, particularly its narrowing, are seen in intervertebral-disc protrusion, and thickening of the flaval ligament, in the projection backward of the posterior margin of the vertebral body, and in the projection of the articular process. The nerves to these tissues are changed in various ways: They are flattened, the sheaths are thickened, the nerve fibers may be divided, and cavities may be formed within them. The narrowing of the intervertebral foramen may be followed by pain in the low back and referred pain, although in some cases no pain is felt when the foramen is recognizably narrowed histopathologically.

Pressure on the nerve in the narrowed intervertebral foramen is reduced somewhat by the reticular fatty tissue which acts as a buffer. The pressure, moreover, tends to be applied to the nerve equally from all sides. As measured in a spinal nerve, the pressure on a normal nerve must be 300 millimeters of mercury or more to cause any pain, but lower pressures applied intermittently may cause pain.

In the case of fused vertebrae in tuberculosis of the spine no pain is induced, because the foramen itself is not changed.

Various lesions producing changes in the intervertebral foramen are followed by oppressive pain. In some such cases the nerve tissue is not changed to any marked degree; and yet the nerve is made hypersensitive, and pain is induced by these changes in the foramen.

The Sacro-Iliac Joint and Low-Back Pain. Dr. Torai Iwahara [36] found that the pathological changes of the joint were caused by tuberculosis in thirty-four patients, and by degenerative arthritis in two hundred and thirty-five patients.

The site of pain or hyperaesthesia in these diseases is identifiable with the distribution of the nerve terminals in the joint and adjacent structures. The superior gluteal nerve is distributed to the lower portion of the joint; the fifth lumbar nerve and the branches of the posterior rami of the first and second sacral nerves run posterior to it. The fibers from the gangliform cord of the sacral sympathetic nerve are seen anterior to it. It remains uncertain whether or not any direct branch of the lumbosacral plexus is concerned in this nerve distribution.

The roentgenogram of the sacro-iliac joint is not easy to interpret, and in an anteroposterior roentgenogram of the joint it is particularly difficult to detect minor changes and to identify the actual area in which these changes are located.

The chief remedy for pain originating in the sacro-iliac joint is fixation, coupled in tuberculous patients with a clearing of the foci. Fixation is effected by either a corset with a belt or by operation.

As demonstrated in rabbits, the best method of joint fixation is by the excision of the joint cartilage and periarticular arthrodesis. Joint fixation and clearing of foci should be performed in combination in those patients in whom tuberculous foci are found exclusively in the posterior part of the joint. In patients in whom the foci are found in the anterior part of the joint, or found extensively beyond that part, periarticular arthrodesis is recommended.

The author advocates the use of the following method for joint fixation in tuberculous patients: A piece of bone approximately six by two by one centimeters is taken from the patient's own ilium and it is set into the joint in order to make a bridge of bone.

The Pathology and Treatment of Radicular Sciatica. Dr. Kengo Yamada [37] and Dr. Tetsuo Ito [38] gave a description of the end results of treatment based on their surgical experience and experience gained from other treatment in approximately 500 patients, among whom are included 185 patients who were treated and previously described by Prof. Kondo. Of the total number of patients, 70 per cent. had intervertebral-disc protrusion, 14 per cent. had thickening of the flaval ligament, and in the remaining 16 per cent. there were patients with adhesive spinal meningitis, spondylolisthesis, and spondylosis.

Statico-dynamic and histological studies were undertaken of the lumbosacral juncture, and neurological studies were made of the nerve elements contained in the intervertebral foramina and vertebral canal. The subject was further investigated through experimental studies of damaged intervertebral discs. Intradural and extradural myelography was utilized and was clinically interpreted.

Of 319 patients who had had the disease for six months to twelve years, 220 were shown to have intervertebral-disc protrusion, twenty-five had thickening of the flaval ligaments, and seventy-four had other types of disease. These patients had been examined and the end results were grouped as *cured, relieved, unchanged, worse,* and *dead.* Of the patients with intervertebral-disc protrusion, 77.7 per cent. were cured, 19.5 per cent. were relieved, 3.2 per cent. were unchanged, 1.4 per cent. were worse, and 0.9 per cent. were

[36] Tokyo, Japan. [37] Yamaguchi, Japan. [38] Yamaguchi, Japan.

(*Continued on page 205*)

MYRON O. HENRY

1893–1953

His life was gentle, and the elements
So mix'd in him that Nature might stand up
And say to all the world, "This was a man!" — *Shakespeare*

These words that have come down through the years fit Dr. Henry aptly. His untimely death on August 31, 1953, brought a great loss to the community and a wide circle of friends. He was a great surgeon who combined rare ability and judgment with a warmth of heart, a cheerfulness, and a sympathy that comes only with deep understanding. Splendid technical training, wide experience, a creative mind, courage, tireless energy, and a fine capacity for friendship made him distinguished.

Dr. Henry was born in Minneapolis, Minnesota, on December 28, 1893. There he attended the public schools and was graduated from the University of Minnesota in 1919. He received his M.D. degree from Minnesota in 1921. From 1921 to 1923 he took special work in orthopaedic surgery at Harvard Medical School. He interned at St. Mary's Hospital, Minneapolis, and at Massachusetts General Hospital. He was a member of Chi Psi and Nu Sigma Nu fraternities. Following his training in Boston, he returned to his home in Minneapolis, to specialize in orthopaedic surgery, and was associated with the late Emil Geist. He and Dr. Geist made a great team, and Dr. Henry enjoyed the inspiration of his elder partner's personality and experience for a number of years.

A devoted family and a lovely home overlooking Lake Harriett were his pride and joy. Here his many friends knew him as one of the most kindly and genial of hosts.

In spite of his heavy responsibilities as surgeon at the Northwestern and Veterans Administration Hospitals and considerable teaching assignments as a member of the Faculty of Medicine of The University of

Minnesota, he remained an ardent student and seldom missed an important orthopaedic meeting. His wide clinical orthopaedic experiences and analytical manner of presentation kept him in constant demand for scientific programs throughout the country.

His contributions to medical literature were many. Among his best writings were his discussions of spinal disabilities. Notable among these was his fusion of the lower spine with "chip grafts". Bone grafts of all types especially interested him, and he performed valuable research along this line.

His ability as an executive in the administration of organized orthopaedic surgery was outstanding. He was a natural leader and a tireless worker in every organization with which he was associated. He consistently fostered organizational advancement, development, and achievement.

In the Clinical Orthopaedic Society, he could always be depended upon for any task; he had the honor of being its President in 1944. In The American Orthopaedic Association, he was a member of several important committees, but his work with its Program Committee was memorable. It is, however, in The American Academy of Orthopaedic Surgeons that he will always be remembered. In 1943 he became the fourth Secretary of the Academy, holding office until 1948. These were among the most progressive and productive years of the Academy's growth. They were filled with major advances to meet the needs of a growing membership. In 1942 the Instructional Courses were started, and the year after that the Audio-Visual Section was added to the program. Without Dr. Henry and the devotion, encouragement, help, and support of a few others, these features of the program would never have reached their present importance or come to fill the need they have in this organization.

During his term of office as President of the Academy in 1949, the Central Office of Orthopaedic Surgery was created.

He served on the Board of Governors of the American College of Surgeons and was a member of the International Society of Orthopaedic Surgery and Traumatology. He was a regular contributor to the Orthopaedic Correspondence Club and took an active part in the Minnesota State Medical Association, as well as in the local Hennepin County Society of which he was a past President.

His life was very full up to the last; even in the past year during his illness he endeavored to keep up a measure of practice which he loved so well, striving to fulfill the demands of a devoted clientele. To the last his professional and medical society contacts were among his greatest pleasures. As a hobby, for many years, he was interested in art and particularly wood carving for which he had considerable talent.

His passing is a grievous loss to orthopaedic surgery and to all who knew him. His accomplishments will be ever present in our minds and hearts. His devoted family has our deepest sympathy.

LETTER TO THE EDITOR

To the Editor
Dear Sir,

It has recently been brought to my attention that the numerical method of rating the results of hip-joint surgery which I use is often called in the United States Judet's rating.

As I have stated publicly several times, especially at the meeting of The American Academy of Orthopaedic Surgeons in Chicago last year (January 1952), I employ, with minor modifications, Professor Merle d'Aubigné's numerical rating, and of course it should be known in your country by his name.

I request publication of this letter in order that this matter may be set to rights.

Yours sincerely,

Robert Judet
Professeur Agrégé d'Orthopédie
3, Square Desaix
Paris XV, France

October 8, 1953

LETTER TO THE EDITOR

To the Editor

Dear Sir,

Inevitably the doctor recognizes in his patients the high proportion of emotional problems. Scrupulous analysis, I am convinced, will show that this is at least 30 per cent. of the total. Here is a challenge to vigilance in diagnosis, and a test of skill in properly directing treatment in these patients. Perhaps in the specialty of gastro-enterology there is a higher percentage of somatic fixations. Not far behind is orthopaedics with frustrations and emotional conflicts disguised as the aching back, the lame shoulder, the stiff neck.

The back, particularly the low back, although opposite the birthplace of the pain, is a convenient repository for complaint, if only to confuse by distance. An ill-paying or emotionally unsatisfying job, a loveless, incomplete marriage, social or sexual impotence—how easy for the aching back to be saddled with the blame! And this hiding place, this refuge in the back, what a crafty choice it is! It can elude not only the searching diagnostic probing of the x-ray, the funneled and retorted distillation of all the humors, or the breakdown by isotope and the magnification by microscope, but also the revelation which fails to appear by wide operative exploration.

Then the frustration takes a new turn. The doctor, exhausted by negative reports, becomes the peeved and frustrated one. The patient has aloofly permitted the guessing game to go on, smug in his Fort Knox—the subconscious stronghold of inaccessibility other than by special permit. And to assuage his ruffled poise the doctor stirs already muddied waters and sedulously proclaims: "This is only a state of mind. Forget it. Take up and become interested in a hobby."

But what better hobby for the neurotic than a baffling series of somatic complaints which defy x-rays, blood tests, photometric and spectroscopic penetration? The neurotic cannot forget. For it is not the pain or the ache which must be forgotten, gladly when possible, but the deep subconscious conflict which must be exposed to be forgotten. Only this will resolve the conscious hurting. Confronting the neuroses with overwhelming negative laboratory evidence is like tilting against windmills. The patients are left even more confused and helpless than before and often are left even to dangerous thoughts of self-destruction, since they can convince no one of the reality of their sufferings.

The orthopaedist has been consulted because the symptoms presented seem to belong in his field. Either the patients themselves or the referring doctors have decided that. Then begins the exhausting grinding and sifting of ultramodern tests, granting the patient's ability to afford these. Frequently this obtains even if other doctors have gone over the same routine carefully. It is possible that sometimes the didactics of lectures on psychosomatic medicine penetrate the orthopaedist's awareness. What course to pursue? And here the decision is based upon the conditioning—emotional, ethical, social, and finally medical—of the orthopaedist himself.

An emotionally maladjusted doctor will have sharp, unfeeling advice to offer: "You are a neurotic!"

As if this sententious pronouncement were diagnosis and cure in one; as if the patient had not always feared the truth of this and were not still left disconsolate; as if this were not but a thin veneer over the cruelty heaped upon the mentally ill in the Middle Ages.

The spectacle of disagreeing doctors, righteous as each may appear, in forensic medicine is particularly hurtful. This actually reaches the state of absurdity when doctors become known as defendants' doctors or claimants' doctors, "for" the insurance company or "for" the lawyer. Here we do not speak of the consciously unscrupulous doctors who examine and testify for the side whose boodle appears the most attractive. We do wish to call attention to the doctor who becomes plaintiff-minded or defendant-minded by subconscious motivation. Thus even before the patient is examined, if he is a litigant or a potential one, he is suspect. If injuries are obvious and disabling, the doctor finds the patient magnifying complaints, delaying recovery, and exaggerating the eventual disability. On the other hand, there is the doctor who considers the insurance company as representing hated authority, bloated plutocracy; this is but the doctor's own projection of infantile antagonism to father rule. Faced with either a welling resentment against a patient or an unidentifiable sympathetic alliance with a patient's suffering, how many doctors are capable of halting, examining, and understanding the feelings which are overwhelming them? And, if they find that these feelings cannot be fathomed, of insisting that another doctor take over the case?

We must not only continuously analyze ourselves to retain the courage of objectivity, but we must understand that the term "malingerer" means a falsifier and the term "neurotic" a sufferer from an illness. The malingerer is a conscious, deliberate planner and schemer, sometimes aided by doctor and lawyer, who is going to extract all that can be squeezed from a case. The neurotic is one whose injury has conveniently coincided with his whole personality mechanism of escape from reality, of return to infantile fixations, and whose subconscious motivation is not primarily the desire for recovery. He seeks a vehicle for transportation to the cherished and unrelinquished pleasures of childhood. The malingerer recovers dra-

matically after a substantial award. The neurotic is satisfied neither with the recovery nor with the results of the finest treatment. It is within this group that we find the "accident-prone" personalities to which we have but recently begun to pay heed.

Then there is the orthopaedist who will carry water on both shoulders in treating the obvious psychoneurotics. This can be easily and profitably rationalized. If the poor deluded sufferer from non-existing disease is permitted to seek relief in a cruel, ruthless world, there are the vultures who will talon him. There are the quacks on diet, the manipulators of luxations, the kneaders of muscles which "impede" the circulation, the modern immersers into healing (even if foul-smelling) waters, the curers by faith and the extractors by stealth. How much better to give injections of cortone and other hormones, vitamins and iron, cholesterol reducer and libido inducer, stimulator and rejuvenator; not to speak of short-wave and ultrasound methods, galvanism and faradism, isotopes and heliotherapy. All this, however, will be medically supervised so that the neurotic, coddled in his complaints, is sympathetically solaced by harmless therapy. When the patient is thus protected from the others, who shall be nameless, such a pontifical doctor hopes that Nature, in her all-encompassing bosom, may enfold the ill one and finally effect a cure. Yet this too is charlatanism.

How is the average orthopaedist failing in his oath, his dedication to his profession and to his specialty? Assuredly he is not of the type we have ironically pictured for condemnation.

Obviously he must first be aware of the many bizarre patterns under which the psychoneuroses may be grouped. The all-too-apparent conversion hysteria, as an example, is readily recognizable. The more subtle manifestations of neurosis, however, can only be exposed by a study of the patient as a personality, not of the body as a mass of component systems assigned by Certifying Boards to various specialists. Grounded as every specialist should be in the basic sciences of anatomy, physiology, chemistry, and pathology, the orthopaedist must be particularly sensitive to the emotional generation of symptoms which come within his specialty. Complaints may have no basis on the plane of organic disease, but that they exist in the fantasy of the patient's subconscious does not make them less disabling, less disharmonious. Is such a personality any less socially and economically crippled than it would be by the discogenic sciatica, the deranged knee joint, or the malunited fracture?

Does it dissuade the syphilophobe if we exhibit repeated negative reports from blood studies and spinal-fluid withdrawals and give a learned dissertation on the reliability of complement-fixation tests? Can a guilt feeling, festering in the subconscious and paraded as an aching back, be eliminated by disc exploration, bracing, or fusion? Do shrewd argument and keen logic exorcise the joint and muscle aches of the immature person who is overwhelmed by marriage and family responsibility? Do we reroute the neurotic's irrepressible return to the parasitism of infantile existence by exposing the hollowness of his claim of actual disability?

The neurotic consults us in a dual role. While consciously hoping for help and desirous of cure, subconsciously he longs for the rejection which will identify us with the hated father authority of his infancy. He is thus easily led into discrediting our ability and escaping from our treatment.

Then why not give up and pass the problem on to our amiable and well adjusted colleagues in psychiatry? The solution is not quite so easy, even if such an attitude did not point up escapism on our part. First we have the onus of making as certain as we can that there is no real organic basis for the complaints. As our acumen is developed both by learning and experience, as well as by discoveries of new tests and testing methods, we recognize heretofore unrecognized disease entities, or entities more commonly present than had previously been suspected; myasthenia gravis is a good example of this. Then, too, we must play a cooperative role in determining how much of a symptom complex is organically engendered, despite the emotional synergy which exaggerated it. Most important of all, however, the patient will not accept at a first or second meeting the sound advice of going to a psychiatrist. This branch of medicine carries with it stigma and shame, and in the present state of the layman's understanding of psychiatry only the desperate who feel themselves verging on dangerous emotional shoals will seek such piloting.

This difficulty, once recognized, cannot be shunned by the orthopaedist. Patience and understanding, and imperviousness to provocation by the patient must be ever present. We are called upon to treat a sick person and, as we are compelled to be unhurried in restoring function to a body stricken by poliomyelitis, so we must be the crutches upon which the psychoneurotic can lean until he can be led to the proper therapist. We cannot disclaim responsibility for casting aside the mentally dyskinetic because we have time only for the physically handicapped. If we are sought out, if in us is reposed confidence, and if by awareness it is revealed to us what must be done for the psychoneurotic, we must help to bring the patient to and through the indicated therapy.

Yours very sincerely,

Harry E. Beller, M.D.
725–26 duPont Building
Miami, Florida

July 15, 1953.

News Notes

The Twenty-first Annual Meeting of **The American Academy of Orthopaedic Surgeons** will be held at the Palmer House, Chicago, Illinois, January 23 through January 28, 1954.

The Annual Meeting of **The American Orthopaedic Association** will be held at the Mount Washington Hotel, Bretton Woods, New Hampshire, June 6 through June 9, 1954.

March 18 through Easter Sunday, April 18, is the period for the sale of Easter seals. The proceeds of this sale are used to extend the services of the **National Society for Crippled Children and Adults, Inc.**

At the last meeting of the **American Academy for Cerebral Palsy,** held in Fort Worth, Texas, October 30–31, 1953, the following officers were elected:

President: Meyer A. Perlstein, M.D.
President-Elect: Lenox D. Baker, M.D.
Secretary-Treasurer: Harry E. Barnett, M.D.

Doctors are urged to make arrangements as soon as possible to attend the **Sixth Pan-Pacific Surgical Congress** to be held in Honolulu, Hawaii, October 7 through October 18, 1954.

An outstanding program, including sessions in all divisions of surgery and related fields, promises to be of interest to all doctors.

The Association office has been appointed as travel agent for those attending the Congress, and it is important that all hotel and travel reservations be made through the Honolulu headquarters of the Pan-Pacific Surgical Association.

For further information, please write to F. J. Pinkerton, M.D., Director General, Pan-Pacific Surgical Association, Suite 7, Young Hotel Building, Honolulu, Hawaii.

The Bureau for Handicapped Children of the New York City Department of Health has recently prepared "Standards Recommended for the Hospital Care of Children with Orthopaedic Handicaps", developed by the Bureau with the assistance of an Orthopaedic Advisory Committee under the chairmanship of Dr. Philip D. Wilson and a technical subcommittee under the chairmanship of Dr. Mather Cleveland. Inclusive sets of standards are given for the Medical Staff, Nursing Staff, Departments of Physical Medicine and Occupational Therapy, Nutrition, Laboratory, X-Ray, and Anaesthesia Departments. Also included are standards for Social Service, Educational Program, Psychological Testing Service, Physical Plant, Policies and Procedures, Records, Visiting Hours, Convalescent Care, Vocational Counseling, and Out-Patient Department.

Copies are available free of charge by application to Helen M. Wallace, M.D., Director, Bureau for Handicapped Children, Department of Health, 125 Worth Street, New York 13, N. Y.

The Sixth Congress of the **International Society of Orthopaedic Surgery and Traumatology** will be held in Bern, Switzerland, from August 30 to September 3, 1954.

Officers of the Society are as follows: Honorary President, Louis Ombrédanne; President, Sir Harry Platt; Vice-Presidents, Etienne Sorrel, José Valls; Treasurer, Charles Parisel.

The Congress will be held under the presidency of Prof. Etienne Sorrel, with Prof. Richard Scherb as Honorary President.

All correspondence should be addressed to the Secretary-General of the Society, Dr. Jean Delchef, 34, Rue Montoyer, Bruxelles, Belgium. Application should be made before May 31, 1954.

The tentative program includes such subjects as the treatment of scoliosis, physiology of sport, physiology of movement, chemical aspects of orthopaedic surgery, bone and joint tuberculosis, bone and joint pathology, and surgery of the hand. Visits to near-by hospitals, research centers, and other institutions have been scheduled, as well as excursions at the close of the Congress.

Arrangements for simultaneous translation (French-English, English-French) have been made through the Swiss branch of International Business Machines.

To be held in Belgrade from May 19 to 22, 1954, is the meeting of the **International Congress of Sports Medicine.** Information concerning this Congress may be obtained from Dr. Vojin Smodlaka, Deligradska 27, Belgrade, Yugoslavia.

AMERICAN SOCIETY FOR SURGERY OF THE HAND

The Ninth Annual Meeting of the American Society for Surgery of the Hand will be held at the Palmer House, Chicago, Illinois, on Friday, January 22, 1954. The preliminary program includes the following papers:

Digital Arthroplasty.
R. E. Carroll, M.D., New York, N. Y.;
T. H. Taber, M.D., New York, N. Y.
Discussion.

Observations on Internal Fixation for Fracture of the Carpal Scaphoids.
Harrison L. McLaughlin, M.D., New York, N. Y.
Discussion.

Evaluation of the Injured Hand by the Grip Test.
Charles O. Bechtol, M.D., Oakland, California.
Discussion.

Hand Deformities in Hansen's Disease (16-millimeter silent motion picture).
Daniel C. Riordan, M.D., New Orleans, Louisiana.
Discussion.

Experiences with the Steindler Flexorplasty at the Elbow (16-millimeter motion picture and 35-millimeter kodachromes).
Leo Mayer, M.D., New York, N. Y.;
Wallace Green, M.D., New York, N. Y.
Discussion.

Methods and Results in Primary Hand and Finger Repairs in the United Kingdom.
Patrick Clarkson, F.R.C.S., London, England.
Discussion.

Capsulectomy of the Interphalangeal Joints of the Fingers (motion pictures and slides).
Raymond M. Curtis, M.D., Baltimore, Maryland.
Discussion.

Preliminary Report on Nerve-Repair Research.
Richard I. Gonzalez, M.D., San Mateo, California.
Discussion.

Studies on the Arterial Circulation of the Hand.
Herbert Conway, M.D., New York, N. Y.;
Richard Stark, M.D., New York, N. Y.
Discussion.

NEW JERSEY ORTHOPAEDIC SOCIETY

The Eighth Annual Meeting of the New Jersey Orthopaedic Society was held on October 10, 1953, at Monmouth Memorial Hospital, Long Branch, New Jersey. President of the Society for 1954 is Dr. Henry Kessler of Newark, New Jersey. Officers elected at the meeting are as follows:

President-Elect: John J. Flanagan, M.D., Newark;
Secretary: William Kruger, M.D., Newark;
Treasurer: Harold T. Hansen, M.D., South Orange;
Executive Committee: Henry Kessler, M.D., Newark;
William Kruger, M.D., Newark;
Harold T. Hansen, M.D., South Orange;
Raphael R. Goldenberg, M.D., Paterson;
Paul J. Finegan, M.D., Trenton;
Arthur Thurm, M.D., Trenton;
Roy R. Ciccone, M.D., Passaic.

The Scientific Program featured several papers, discussions, and presentation of cases by members of the Orthopaedic Staff of Monmouth Memorial Hospital. Among the papers presented were:

Repair of Defect in the Radius Due to Osteomyelitis.
Marshall Bergen, M.D., Jersey City.

Hereditary Contracture of the Elbow and Absence of the Patella.
Harold C. Benjamin, M.D., Jersey City.

Neonatal Fractures.
Andrew Dedick, M.D., Red Bank.

Orthopaedic Experiences in Korea.
Edwin J. Otis, M.D., Long Branch.

One-Hundred-and-Eighty-Degree Rotation of the Leg on the Knee with Calcaneovalgus Deformity of the Feet.
Joseph Dietz, M.D., Trenton.
Osteogenic Sarcoma with Metastasis.
Raphael R. Goldenberg, M.D., Paterson.
Anatomical Factors Related to Severity of Root Compression by Disc.
Edward B. Schlesinger, M.D., New York, N. Y.

THE INTERNATIONAL CONGRESS OF HYDROCLIMATOLOGY AND THALASSOTHERAPY

The International Congress of Hydroclimatology and Thalassotherapy will take place in Yugoslavia in the cities of Opatija, Rab, Split, and Dubrovnik (on the Adriatic Coast) from May 8 to May 16, 1954. Organized by the Union of Yugoslav Medical Societies and the International Federation of Thermatology and Climatology, the meeting is under the patronage of Marshal Tito. Chairman of the meeting is Prof. A. Stampar, President of the Yugoslav Academy of Sciences and Arts, of Zagreb.

The provisional scientific program follows:

Section I: Thalassotherapy (under the presidency of Prof. E. Sorrel, Paris, France).
Bioclimatic Factors in Thalassotherapy.
Chairman: Prof. H. Pfleiderer, Kiel, Germany.
Significance of Thalassotherapy in Modern Treatment of Osteo-Articular Tuberculosis.
Chairmen: Prof. Dalla Torre, Venice, Italy;
Prof. D. Jovčić, Belgrade, Yugoslavia.

Section II: Medical Hydroclimatology (under the presidency of Prof. M. Messini, Rome, Italy).
Neurovegetative System and Hydroclimatic Treatment.
Chairmen: Prof. D. Santenoise, Paris, France;
Jn. Prof. O. Yenal, Istanbul, Turkey.
Significance of Hydroclimatic Treatment in Rheumatic Diseases.
Chairmen: Prof. A. Böni, Zürich, Switzerland;
Dr. D. Čop, Zagreb, Yugoslavia.
Significance of Hydroclimatic Treatment in Diseases of the Respiratory Tract (Tuberculosis is not included).
Chairmen: Prof. Justin Besançon, Paris, France;
Prof. E. Phocas, Athens, Greece;
Jn. Prof. M. Ciglar, Sarajevo, Yugoslavia.
Significance of Hydroclimatic Treatment in Hypertensive Diseases.
Chairmen: Prof. Gollwitzer-Meier, Hamburg, Germany;
Prof. V. Arnovljević, Belgrade, Yugoslavia.

Section III: Social, Economic, Technical, and Juridical Questions in Connection with Hydroclimatology (under the presidency of A. Schirmer, Baden, Germany).
The Question of Analytical Methods in the Examination of Mineral Waters.
Chairmen: Prof. F. Scheminzky, Innsbruck, Austria;
Prof. O. Gübeli, Zürich, Switzerland;
Prof. Mascherpa, Pavia, Italy.
Hydroclimatic Treatment from the Viewpoint of Social Medicine.
Chairmen: Prof. Parisot, Nancy, France;
Prof. M. Bauer, Bonn, Germany;
Prof. A. Hahn, Zagreb, Yugoslavia.
Noise Control in Spas and Climatic Resorts.
Chairmen: Prof. F. Rütten, Bad Neuenahr, Germany;
Prof. Kraft, Bern, Switzerland.
The Question of Propaganda for Hydroclimatic Resorts.
Chairmen: Prof. Senger, Zürich, Switzerland;
Dir. Hain, Bad Hall, Germany.

Additional information may be obtained upon application to Prof. Čedomil Plavšić, Zeleni venac 1, Belgrade, Yugoslavia.

The Industrial Medical Association will hold its Thirty-ninth Annual Meeting at the Hotel Sherman, Chicago, Illinois, April 26 to 30, 1954. Industrial medical problems, as well as the over-all health and safety of industrial workers, will be discussed. The conference will be attended by five different groups interested in the field of industrial health. These represent the medical, surgical, dental, and nursing phases of health and safety in private industry and government agencies.

AMERICAN COLLEGE OF SURGEONS

Sectional Meetings

The medical profession is invited to attend any of the six Sectional Meetings of the American College of Surgeons to be held between February 1 and May 19, 1954, in different parts of the United States, in Montreal, Quebec, Canada, and in London, England. There is no geographic restriction upon attendance, and those who are interested may select the session most convenient to them in time and place.

Charlotte, North Carolina, February 1 to 3, 1954

The first Sectional Meeting will be held in Charlotte, North Carolina, February 1 to 3. A local committee, headed by Dr. Thomas D. Sparrow, will act as hosts.

Reno, Nevada, February 25 to 26, 1954

Dr. Kenneth H. Maclean, the Committee on Arrangements, Fellows of the American College of Surgeons in Nevada, and the Reno Surgical Society have planned an interesting program. Time will be devoted to such aspects of atomic defense as atomic injuries, plasma expanders, mass treatment of burns, and rescue and survival operations. Of particular interest to orthopaedic surgeons will be the Symposium on Trauma presented by Dr. Edmund D. Butler, San Francisco, California, Captain Luther G. Bell, San Diego, California, and Dr. Gerald B. O'Connor, San Francisco, California.

Omaha, Nebraska, March 1 to 4, 1954

At Omaha, Nebraska, a larger-than-usual meeting has been planned by Dr. Earl A. Connolly and his Committee on Arrangements. Included in the arrangements are specialty programs not planned for other Sectional Meetings. Of interest to orthopaedic surgeons will be the Wednesday Meeting, devoted to orthopaedic surgery and presided over by James W. Martin, M.D. The program includes:

Diagnosis and Treatment of Low-Back Problems.
G. W. N. Eggers, M.D., Galveston, Texas.
Fractures in Childhood.
William A. Larmon, M.D., Chicago, Illinois.
Injuries of the Wrist and Carpus.
Fred C. Reynolds, M.D., St. Louis, Missouri.
The Cervical Syndrome.
Ruth Jackson, M.D., Dallas, Texas.
Surgery of Poliomyelitis.
Carroll B. Larson, M.D., Iowa City, Iowa.
Treatment of Malleolar Fractures and Especially the Role of the Medial Malleolus Ligament.
Rudolph S. Reich, M.D., Cleveland, Ohio.

On the final day of the Meeting, there will be another session devoted to orthopaedic surgery with William R. Hamsa, M.D., presiding. Papers read at this session will be:

Arthroplasty of the Hip Joint.
Alexander Gibson, M.D., Winnipeg, Manitoba, Canada.
Arthroplasty of the Hip.
Carroll B. Larson, M.D., Iowa City, Iowa.
End Results of Calcaneal Fractures.
Rudolph S. Reich, M.D., Cleveland, Ohio.
Hydrocortisone in Office Orthopaedics.
Fred C. Reynolds, St. Louis, Missouri.
Soft-Tissue Injuries about the Shoulder.
Olav Rostrup, M.D., Edmonton, Alberta, Canada.
Skeletal Injuries about the Shoulder.
Oscar P. Hampton, Jr., M.D., St. Louis, Missouri;
Allen F. Voshell, M.D., Baltimore, Maryland.

French Lick Springs, Indiana, March 15 to 17, 1954

The fourth Sectional Meeting will be held at French Lick Springs, Indiana; the Indiana Chapter of the American College of Surgeons and the local Committee on Arrangements, headed by Dr. Carl H. McCaskey, have planned an interesting meeting.

Montreal, Quebec, Canada, March 31 to April 2, 1954

From March 31 to April 2, Montreal will be host city to the fifth Sectional Meeting of the season. Dr. Harry S. Morton and his local Committee, Dr. J. V. V. Nichols, President of the Montreal Ophthalmological Society, Dr. C. B. Stewart, President of the Canadian Urological Association, Dr. Antonio Samson, President of Société d'Orthopédie et Traumatologie de la Province de Quebec, and others are collaborating to make this meeting one of the finest.

Of interest to orthopaedic surgeons will be the speech to be made on April 1, 1954, by Francis C. Grant, M.D., Philadelphia, Pennsylvania, on the intervertebral disc and a Symposium on Trauma with Bradford Cannon, M.D., and Edwin F. Cave, M.D., Boston, Massachusetts. Dr. Cave will speak on Injuries to the Carpus and the Lower Ends of the Radius and Ulna. The afternoon of the third day of the Meeting will be devoted to papers on orthopaedic surgery read by A. A. Butler, M.D., Montreal, Quebec. Louis P. Roy, M.D., Quebec, Quebec, and Ulric Frenette, M.D., Montreal, Quebec. These papers will be followed by a panel discussion on Fracture of the Neck of the Femur: Judet Operation versus the Smith-Petersen Nail with Prof. R. I. Harris, Toronto, Ontario, James Grant Shannon, M.D., Montreal, Quebec, and Antonio Samson, M.D., Montreal, Quebec.

London, England, May 17 to 19

For the first time since 1914, a meeting of the American College of Surgeons will be held in London. Sir Cecil Wakeley, President of the Royal College of Surgeons of England, is Chairman of the Committee on Arrangements. Prior to this meeting, the Association of Surgeons of Great Britain and Ireland will meet in Leeds, May 13 to 15, and visitors are invited to attend this Meeting as well. The International Society of Surgery invites registrants at the London Meeting to visit the special sessions and clinics in Paris, May 21 to 22. Among the many interesting features of the London Meeting will be a discussion on Internal Fixation of Fractures in the Past and Future by Sir Reginald Watson-Jones and a paper on The Present Status of Internal Fixation of Fractures of Long Bones in the United States by Edwin F. Cave, M.D., of Boston, Massachusetts, as well as a panel discussion on hand surgery which includes Michael M. Mason, M.D., Chicago, Illinois, Robert Guy Pulvertaft, F.R.C.S., Derby, England, Georges Cloutier, M.D., Montreal, Quebec, Canada, and Patrick Clarkson, F.R.C.S., London, England.

Inquiries about details on any of the Sectional Meetings should be addressed to Dr. H. Prather Saunders, Associate Director, American College of Surgeons, 40 East Erie Street, Chicago 11, Illinois.

CORRECTION

An error appeared in the report of the Annual Meeting of The American Orthopaedic Association in Hot Springs, under Proceedings, page 1034 of the October 1953 issue of *The Journal*. At the President's reception, held on Monday evening, June 29, the members of the Association elected at the Annual Meeting in 1952 were presented to the membership. The newly elected members, listed in the report as having been presented at the President's reception, were elected at the Second Executive Session held on July 2, 1953.

DISCUSSION

The Japanese Society of Orthopaedic Surgery

(*Continued from page 197*)

dead; of those with thickening of the flaval ligaments, 40 per cent. were cured, 36 per cent. were relieved, 12 per cent. were unchanged, and 12 per cent. were dead. It will be seen from these figures that the end results are better in patients with intervertebral-disc protrusion than in those with thickening of the flaval ligaments.

Various surgical procedures, such as laminectomy, partial laminectomy, facetectomy, osteoplastic hemilaminectomy, and combinations of these, have been adopted for the treatment of intervertebral-disc protrusion. Judged from the end results, it was statistically impossible for one to decide which of these procedures is the best. It was also found from a study of the end results that each procedure left the local condition uncured in about 40 per cent. However, the number of patients cured was statistically large among those with severe neurological symptoms; the number of patients cured was statistically even larger among those in whom adherent nerve roots were observed during the operation than in those without such adhesions.

The end results might seem to suggest a change of tone induced by operative intervention in the structure of the lumbosacral juncture. On the other hand, the end results may be taken to indicate that an operation for intervertebral-disc protrusion is an operation for the relief of nerve-root pressure, as Greenwood has stated.

Book Reviews

CLINICAL ORTHOPAEDICS. No. 1. Anthony F. DePalma, M. D., Editor-in-Chief. Philadelphia, J. B. Lippincott Company, 1953. Single issue $6.00; on a sustaining basis, $5.00.

This is the first issue of a new periodical sponsored by The Association of Bone and Joint Surgeons. It is published in book form, cloth-bound, and is printed in a pleasing fashion with a two-column format and many black-and-white illustrations of high quality.

As stated in the preface, two issues annually are contemplated with the number being increased as the need arises. Each issue is to be divided into two sections,—the first, a symposium or group of articles dealing with some particular aspect of orthopaedic surgery, the second, a collection of miscellaneous articles selected so as to be of interest not only to orthopaedic surgeons but also to general practitioners and to those in allied specialties.

In the present issue the first section is devoted to children's orthopaedics. There are fifteen short articles dealing with a wide variety of subjects, ranging from such general topics as arthritis in children and posture to such specific problems as adolescent flared ribs, calcaneovalgus foot in the newborn, and congenital separation of the symphysis pubis.

In the second section, there are nine articles dealing with a variety of subjects, including backache and sciatic pain, criss-cross tibiofibular graft for non-union, Ewing's tumor, poliomyelitis, the physiological basis of bone-graft surgery, relation of tarsal anomalies to spastic and rigid flat-foot, myositis ossificans, and Paget's disease.

The articles are for the most part interesting and well presented. However, some have a distinctly textbook flavor and give the impression of being rather sketchy surveys of the subject in question. Although of educational value, they do not seem to offer much which is new or which is not readily available in many good textbooks. Other articles are perhaps not so convincing as they might be, because of failure to furnish supporting data in the form of case reports, follow-up studies, and roentgenograms. For example, in an article entitled "Congenital Separation of the Symphysis Pubis", apparently only three of ten cases were treated for the condition. No postoperative roentgenograms of these cases are offered and no follow-up examinations are reported other than to state that the pubic arch was stable in these cases. Similarly, in an article entitled "Metatarsal Resection for Disabilities of the Foot", fifty-two feet were operated upon, but no follow-up study is reported, nor is there any report of results.

With a newly organized editorial staff, typographical and grammatical errors are perhaps unavoidable. However, such errors must be kept to a minimum in a first-class publication. It is to be hoped that, after this "shake-down cruise", *Clinical Orthopaedics* will not be marred by such errors as are present in this issue. As an example, on page 114 the sentence "In some cases lacking adequate suspension, the traction apparatus may become disassembled, causing the fracture to re-displace; this mitigates for a less favorable result."; on page 10 the phrase "chondral positions"; and on page 14 the sentence "The symptoms are not great." are examples of editorial laxity. Similarly in the index, the heading classifying such men as Fuller Albright, Arthur Steindler, and Dallas B. Phemister as laboratory technicians would hardly seem proper.

This new periodical is launched on the premise that there are not enough existing outlets in the medical literature for all the worth-while orthopaedic work to find its way into print. It is too early to form an opinion as to the validity of the premise. Future issues of *Clinical Orthopaedics* will settle the point.

INSTRUCTIONAL COURSE LECTURES. VOL. X. The American Academy of Orthopaedic Surgeons. Charles N Pease, Editor. Ann Arbor, J. W. Edwards, 1953. $12.00.

With each Annual Meeting of The American Academy of Orthopaedic Surgeons, the Instructional Courses have become a more important feature of the program. The members of the early Committees on Instructional Courses must feel rewarded for their efforts as they have observed how members and guests attending the Scientific Sessions have availed themselves of this educational opportunity.

The value of the Instructional Courses has been augmented by the publication of the lectures, thus making them available to many who were unable to attend the Academy Meetings and a valuable record for all.

This year's Volume is most attractive, the glossier paper now used making possible more satisfactory reproduction of the illustrations than did the paper used in the earlier Volumes. Great credit is due Dr. Pease and his associates for their work on these Instructional Course Lectures.

Volume X, as well as the earlier Volumes, should have a place in the library of every orthopaedic surgeon eager to keep in touch with the development of his specialty.

ROENTGEN-DIAGNOSTICS, Vol. II, Skeleton (Part 2). H. R. Schinz, W. E. Baensch, E. Friedl, and E. Uehlinger. First American Edition (Based on the Fifth German Edition). English Translation arranged and edited by James T. Case, M.D., D.M.R.E. New York, Grune & Stratton, 1952. $45.00.

Volume II of this masterful translation of the great German work on roentgen diagnosis completes that section of the work which is of particular interest to orthopaedic surgeons—the roentgen diagnostics of the skeleton. The material contained in this volume is that which appeared in the third and fourth installments of the German Edition. These installments were reviewed in *The Journal* for July 1951 and January 1952.

The volume is concerned with tumors of bone (primary bone tumors and metastatic bone tumors), skeletal malformations, systemic diseases of bone, the various types of arthropathy, and abnormal conditions and diseases of the skull, vertebral column, and soft tissues. The book concludes with diagrams of skeletal localization and tables of differential diagnosis of skeletal diseases; reference is made to age and sex incidence, symptoms, and histological findings.

Once again the publishers are to be congratulated upon the excellence of the printing and the reproduction of illustrations; they are to be particularly thanked for making available to an English-speaking readership one of the indispensable works of medical literature.

POLIOMYELITIS. Papers and Discussions Presented at The Second International Poliomyelitis Conference. Compiled and Edited for the International Poliomyelitis Congress. Philadelphia, J. B. Lippincott Company, 1952. $7.50.

This book contains the papers, discussions, and exhibits presented at The Second International Poliomyelitis Conference held in Copenhagen in September 1951. It is similar to the previous volume which covered The First International Poliomyelitis Conference in 1948. It is, however, considerably larger, comprising 543 text pages as compared with 353. Furthermore, there are many more illustrations both in black and white and in color.

There are seven symposia or reviews, each comprising a series of papers dealing with such topics as the virus and its interaction with the host cell, the Coxsackie group of viruses, clinical and laboratory aspects of the differential diagnosis in acute poliomyelitis, immunity and resistance in poliomyelitis and other virus infections, and finally, the pathology, pathophysiology, treatment, and ecology of poliomyelitis. In a final section there is a summary of the various exhibits presented at the Conference.

Within the covers of this book can be found information on literally every facet of the poliomyelitis problem. It summarizes the tremendous strides that were made between 1948 and 1951 in the study of this disease. Two discoveries of far-reaching significance are presented,—namely, the development of a technique for growing the virus in roller-tube tissue cultures by Enders and his co-workers and the perfection of a complement-fixation test in which baby-mouse brain is used to prepare the antigen by Casals and Olitsky.

Presenting, as it does, work from all corners of the world in a readily available form, the volume is of great value and can be recommended highly to all interested in this problem.

SYNOVIAL FLUID CHANGES IN JOINT DISEASE. Marian W. Ropes, M.D., and Walter Bauer, M.D. Cambridge, The Commonwealth Fund, Harvard University Press, 1953. $4.00.

This monograph presents the results of the authors' extensive studies of normal and pathological joint fluids during the last twenty years, as well as a review of the literature on this subject. It presents the current concept of the nature of joint fluid and summarizes the characteristics of normal joint fluid as shown by studies of human postmortem fluid and of fluid obtained from cattle immediately after slaughter.

With these results for comparison, the changes caused by disease are presented. The findings in 1,500 specimens of synovial fluid from patients treated at the Massachusetts General Hospital for various joint diseases are summarized and analyzed with reference to gross appearance, bacteriology, cytology, and various physical and chemical properties. The variations in these are recorded first in a general way and then the findings in specific diseases are given and their value in diagnosis is discussed. The fluid findings definitely serve to differentiate diseases of traumatic origin (traumatic synovitis, degenerative joint disease, osteochondritis dissecans, and Charcot joints) from those of inflammatory origin, notably rheumatoid arthritis and specific infectious arthritis. Between these two extremes are diseases in which the joint fluids show changes resembling those found in both the traumatic and the infectious groups. This group includes hypertrophic pulmonary osteo-arthropathy, hemophilia, disseminated lupus erythematosus, gout, rheumatic fever, arthritis due to hypersensitivity, and villonodular synovitis among others.

In a pocket inside the back cover of the book is a large table which summarizes all the findings. This should prove of considerable aid in interpreting the findings following joint aspiration.

This book is a real contribution to our knowledge of joint disease. The reader is impressed both by the immense amount of information which has been accumulated and by what remains to be learned. No previous study even approaches this one from the point of view of completeness. The book should prove indispensable to all physicians concerned with joint diseases and should stimulate further endeavor along this important and fundamental line of approach to the baffling problems of joint disease.

TUMORS OF BONE. A Roentgenographic Atlas (Annals of Roentgenology, Vol. XXI). Bradley L. Coley, M.D., and Norman J. Higinbotham, M.D. New York, Paul B. Hoeber, Inc., 1953. $10.00.

The Atlas is Volume XXI of the series of *Annals of Roentgenology*. As has always been true of the works in this series, the illustrations are excellent and clearly demonstrate roentgenographic details. The book contains a reasonably adequate and accurate index. Since the material is presented in atlas form, there are the inevitable limitations to which an atlas is subject. It is necessary for the student to read all of the text and the captions most carefully, since the text is concisely put together and few words are wasted.

Many of the roentgenographic reproductions are accompanied by photographs of longitudinal gross sections and, in certain instances, by photographs of the microscopic sections as well. If it were carried out completely, such a method of presentation would be ideal. Thus the value of the book would have been enhanced had it been possible to have photographs of both gross and microscopic sections, preferably in color, in all cases. Nevertheless, the material as presented gives a good demonstration of many bone tumors and such conditions as may be confused with these tumors.

Most phases of the various types of malignant tumor are excellently presented. The section on Benign Tumors and that on Non-Neoplastic Conditions of Bone Simulating Bone Tumor seem less accurately and less thoroughly organized. In these sections there are several illustrations of lesions for which the diagnosis had not been adequately proved. The authors have been careful in each instance, however, to note the lack of histological confirmation.

Some readers may criticize the references to Coley's toxins in the section on Reticulum-Cell Sarcoma. However, until there is further evidence that the toxins are definitely not of value, this does not become a significantly serious objection.

For the student who enjoys the atlas type of presentation and a very concise text, this book is recommended.

CHIRURGIE PLASTIQUE CUTANÉE. Pratique courante. J. Francillon et P. Truchet. Paris, G. Doin et Cie, 1953. 2.200 fr.

The stated purpose of this monograph is to present to the general surgeon a review of advances in plastic surgery. The authors have described many procedures, the indications for their use, and the details of technique necessary for their proper execution. The result is adequate but somewhat uncritical, because much of the material is drawn from standard texts. For example, the authors are guilty of the same error into which nearly every recent writer in the specialty has fallen. They have reproduced many of the patterns of bizarre-shaped flaps which have appeared in almost every text in the last century and which give a very false impression of the ease with which skin can be manipulated for wound closure. They have failed to discuss the composite graft from the ear which was developed in this country during World War II. The discredited method of closure of a sacral pressure sore with multiple radial flaps, illustrated on page 159, could well have been omitted, as could illustrations of several other methods which have not stood the test of time.

The anatomy and histology of the skin, the techniques of proper wound closure, the significance of nutrition in relation to wound healing, and the practical application of methods of skin transplantation, both as free skin grafts and as flaps, to a varied assortment of injuries and deformities are all treated in detail. These discussions should prove helpful to the general surgeon interested in dealing with the problems of plastic surgery more effectively.

FUNCTIONAL DISORDERS OF THE FOOT. Ed. 3. Frank D. Dickson, M.D., and Rex Diveley, M.D. Philadelphia, J. B. Lippincott Company, 1953. $6.75.

This book is the Third Edition of an excellent text which has already received wide acceptance. In addition to the discussions in the previous editions of all the basic aspects of foot disorders, fresh material of fundamental importance has been added. This includes the interesting observations of Harris and Beath made from examination of 3,600 inductees in the Canadian Army. Although the surgical treatment of the foot changes little, it is encouraging to find that some of the older operations which failed to give satisfactory results have been omitted from this edition; new procedures for the treatment of flat-foot, plantar warts, and hallux valgus have been added. Altogether the broad presentation, splendid illustrations, concise discussions, and sound viewpoint make this text an invaluable addition to any orthopaedic library.

25 JAHRE UNFALLKRANKENHAUS WIEN. Vienna, 1952.

One of the pioneers among clinics devoted entirely to traumatic surgery, the *Unfallkrankenhaus* still may be regarded as a model by all similar institutions. This little brochure, brought out on the occasion of the twenty-fifth anniversary of the Clinic, offers some interesting statistics which throw light on the administrative as well as the clinical problems of such an institution. Both the text and the attractive illustrations give a vivid picture of the routine procedures in the Clinic. There are detailed descriptions of the procedures

followed in the initial examination, in physical therapy (which includes active motion of all unaffected joints from the day of injury), and in treatment of ambulatory patients.

The history of this institution is inextricably interwoven with the work and the career of its Director, Dr. Lorenz Böhler. To him and his colleagues at the *Unfallkrankenhaus*, all who work in the field will want to extend their best wishes for the next twenty-five years.

DIE OSTITIS DEFORMANS PAGET. Dozent Dr. med. Habil. W. Hirsch. Leipzig, Georg Thieme, 1953. RM 22.

Paget's disease, despite the careful clinical investigations of many observers during the last seventy-five years, remains essentially a descriptive entity of which the inciting cause is entirely unknown and in which the underlying continuing changes in bone structure remain independent of changes in any other tissue. Hirsch's monograph on the subject brings together, in the classical manner, most of the relevant clinical, chemical, and roentgenographic observations and also provides a summary of his own work, which principally consists in measurements of blood calcium, phosphorus and phosphatase, marrow aspirations, and descriptions of the roentgenographic findings. As a reference work it is of value, since many facts which are scattered in the literature and are rarely found in textbooks are brought together. The author's 136 cases enable him to write with authority. The roentgenographic appearances are well illustrated and the organization of the index and bibliography are excellent. Since all the treatments which have been suggested for this disease have been without consistent benefit, the chapter on therapy is appropriately short. One would have expected, however, more information on the orthopaedic aspects of treatment, as exemplified by preferential intramedullary nailing, or the arguments for and against the treatment of incomplete fissure fractures. For the general reader, however, the subject is presented with sufficient detail so that he may easily appreciate the character of the disease and of its problems.

DIE OSTEOMALAZIE. Dr. med. Markus Wernly. Stuttgart, Georg Thieme Verlag, 1952. DM 14.40.

This 100-page monograph is a presentation of the several kinds of osteomalacia with an attempt to reduce the causative mechanisms to a few fundamental defects. Primary, according to the author, is vitamin-D deficiency, either through inadequate availability to the organism or through increased needs. The most important contributory defect is that concerned with the sex hormones in the female. The author's work is based on a rather extensive review of the clinical literature and on twelve cases. The various theories which have been advanced to explain the occurrence of osteoid are given in simple form, and the extensive bibliography of 1,950 listings is a valuable supplement. For modern readers interested in the osteomalacia of renal origin, the details given concerning the pathogenesis of these lesions, and the data, roentgenograms, and photomicrographs of the author's twelve cases seem inadequate. The section on the modes of action of vitamin D is also less extensive than one would like, in view of the author's emphasis on vitamin-D deficiency as the primary etiological mechanism. However, the simplicity of presentation and the fairness shown in the explanation of conflicting theories makes this small book a valuable introduction to the complexities of the metabolism of bone.

THE MUSCULOSKELETAL SYSTEM. A Symposium Presented at the Twenty-first Graduate Fortnight of the New York Academy of Medicine, October Ninth to Twentieth, 1950. Edited by Mahlon Ashford, M.D. New York, The Macmillan Company, 1952. $6.50.

The current trend in orthopaedic surgery toward a closer alliance with the basic sciences is exemplified in this small volume. Each of the sixteen chapters is of fundamental interest to the orthopaedic surgeon. The authors are distinguished in their fields, and their lectures are short, clearly written, and well edited.

The contents primarily concern the physiological aspects of the musculoskeletal system, including the chemistry of connective tissue, physiology of muscle, metabolic bone disease, collagen disease, and uric-acid metabolism.

This book is recommended for the orthopaedic fellow in training, as well as for the orthopaedic surgeon; it would be well for Board Candidates to make a careful study of its contents before proceeding to their examinations. The reviewer does not know where else such authoritative information on these subjects is so conveniently set forth.

MAN'S BACK. Theodore A. Willis, A.M., M.D., F.A.C.S. Springfield, Illinois, Charles C. Thomas, 1953. $9.50.

In his preface, Dr. Willis states that this "monograph is presented in an attempt to salvage, and to discuss from a practical viewpoint, the jetsam from . . . successive waves" of discovery of new facts in regard to the back. He does not attempt to trace material back to its original source, to credit modifications, or to furnish a bibliography or an authors' index. Dr. Willis recognizes that such a "book . . . will probably never acquire the dignity of a textbook", but nevertheless, he acknowledges that he "has enjoyed expressing personal opinions based upon his own experience".

The admission of these self-imposed limitations serves as an effective rebuttal to such criticisms as a reviewer might offer. The quality and soundness of Dr. Willis's contributions to our knowledge of the anatomy of the back in themselves lend authority to anything he might write on the back.

Man's Back constitutes a general, entertainingly written, but brief and rather superficial discussion of most of the phases of the human back and problems related to it. It begins with a description of the embryology and anatomy. Injuries and diseases are discussed, but unfortunately not in sufficient detail to meet the requirements of the orthopaedic surgeon or resident. The intervertebral-disc syndrome is covered in six pages, while the section on tumors occupies a chapter of eleven pages. The chapter on scoliosis consists of nine pages, about half of which are photographs. There is a short chapter on psychoneurosis and malingering, one on physical therapy and braces, and another on operations, in which the subjects of laminectomy and costotransversectomy are allotted the majority of the attention and space.

The reviewer, after a thorough study of this monograph, has the feeling that, although it may faithfully portray the author's views on the subject, it fails to present a balanced, thorough, and documented discussion to meet the needs of either the orthopaedic surgeon or the resident.

SLIPPED CAPITAL FEMORAL EPIPHYSIS. Armin Klein, M.D., Robert J. Joplin, M.D., John A. Reidy, M.D., and Joseph Hanelin, M.D. Springfield, Illinois, Charles C. Thomas, 1953. $6.75.

This volume is one in the series of American Lectures in Roentgen Diagnosis. A little book of 128 pages, it is essentially a collection of roentgenograms. There are about fifteen full pages of text. The first forty-seven pages are devoted to reproductions of roentgenograms of normal hips in children from the age of six days to eighteen years, made at intervals of one year after the first year. There is a set of roentgenograms for males and one for females with eleven additional roentgenograms. Twenty-eight of the roentgenograms are of hips in children below the age of nine years. These have no real relation to the subject of the monograph, as slipping of the capital femoral epiphysis does not occur below this age. There is so little difference between male and female hips, hardly more than might occur between different males or females at each age, that the illustrations are repetitious. Similarly, the eleven additional roentgenograms repeat what is seen in the previous ones with variations in the captions. The roentgenologist and the orthopaedic surgeon will be familiar with the findings in these normal roentgenograms, although they may be of use to the student and the general practitioner.

In all, some sixty-nine pages and thirty roentgenograms are devoted to the diagnosis and treatment of slipped capital femoral epiphysis. This section is a summary of the findings in sixty-eight patients or eighty-one hips in the authors' series. The chapter on diagnosis consists of three pages of text, five sets of roentgenograms, including some made during treatment, and two sets of drawings. The section on diagnosis could have been arranged in a more orderly fashion and could have been more complete. For example, some of the clinical features which are included in the section devoted to conclusions more properly belong here. One would expect diagnosis to be the most important part of a book of this sort.

The remainder of the book is devoted to treatment, in three sections, and is limited to the authors' experience. Fifty-four hips had slipping of less than one centimeter and were nailed without reduction, a Smith-Petersen nail being used. Twenty-seven hips had displacement of more than one centimeter and were treated by closed or open reduction, the majority being treated by open reduction. The slipping is classified as minimal or marked, depending upon whether it is less or more than one centimeter. Patients with slipping of more than one centimeter might well have been divided into groups with moderate and marked slipping. The technique of open reduction, nailing, and postoperative care is described. The head is separated from the neck and is replaced,—a procedure which has been found by nearly all orthopaedic surgeons to lead to aseptic necrosis in a moderate percentage of patients. The authors do not describe removal of the callus in the inferior angle between the head and neck, which may in part explain their smaller incidence of aseptic necrosis as well as the incomplete reduction in most patients.

The section devoted to conclusions includes clinical data which more properly should have been included in the chapter on diagnosis. No control cases are reported, nor is the natural course of the disease described. It is well known that a slight or moderate slipping of the upper femoral epiphysis will heal without surgical intervention with a good clinical result and no aseptic necrosis for many years. Surgery, to be justifiable, must do better than this. It is also known that the percentage of good results and the percentage of normal function in each patient depends upon the method of evaluation and the strictness of its application. The authors have used a method of evaluation of results which is at best incomplete. The percentages reported by the authors in tabulation of the results from their open reductions suggest that higher standards might well have been used. The occurrence of three subtrochanteric fractures after nailing is startling. Most of the reductions were incomplete as shown by roentgenogram in the hips used for illustration. In Figure 63 there was no reduction at all, the improved appearance being due to the natural healing of the disease. There was a large marginal lip posteriorly in several of the illustrative cases, for example Figures 53-C, 67-C, 68-E, and 68-F, whereas Figure 69 can hardly be called an excellent result.

It is unfortunate that the authors have included only a minimum of references and have not given credit to other workers from whom they have learned. It is also disappointing that they have made no mention of

other effective treatments, some of which have been used for a longer period of time in more cases than their own.

The most important feature in the treatment of slipping of the upper femoral epiphysis today is early diagnosis and early treatment before reduction is necessary. In this way really excellent results can be assured in a very large percentage of cases. This phase of the subject has hardly been mentioned by the authors.

The illustrations are well chosen and are well reproduced, and the book is printed in an attractive fashion. In spite of its limitations, it should be of value to the physician who is interested in this important subject.

FUNCTIONAL AND SURGICAL ANATOMY OF THE HAND. Emanuel B. Kaplan, M.D., F.A.C.S. Philadelphia, J. B. Lippincott Company, 1953. $10.00.

A sound knowledge of anatomy is indispensable to good surgical technique. Since the hand is an extremely complicated mechanism, the surgeon who operates upon it must have extensive and detailed knowledge of its morphological and functional anatomy. In this new work will be found clear and precise descriptions supplemented by an abundance of beautiful, original illustrations (132 of them), all of which are designed to give the surgeon complete, practical, and indispensable information on the hand. It is a textbook of anatomy of great excellence, and its usefulness is enhanced because it is oriented toward and clarifies surgical problems. It belongs with the few familiar books in surgeons' libraries to which they turn instinctively for help in solving surgical problems. It should be required reading for every surgeon who deals with the hand, and it is safe to say that, once read, it will be frequently consulted as special problems arise.

RECURRENT DISLOCATION OF THE SHOULDER. James A. Dickson, M.D., Alfred W. Humphries, M.D., and Harry W. O'Dell, M.D. Baltimore, The Williams & Wilkins Company, 1953. $4.50.

This monograph is a useful reference source for the surgeon interested in recurrent dislocation of the shoulder. The subject is approached on a rather broad base, including the embryology, phylology, anatomy, and dynamics of the shoulder mechanism; but the reader is disappointed in the brevity with which these phases of the problem are discussed, and in a failure to relate them more substantially to recurrent dislocation of the shoulder. The major portion of the book is devoted to the pathology and surgical treatment of this condition, and is essentially a compendium of previous reports, culminating with the operation which the authors have recently described. Discussion of the excellent attached bibliography is somewhat depreciated in value by inaccuracies in quoting the references under consideration.

SURGERY AND THE ENDOCRINE SYSTEM. Physiologic Response to Surgical Trauma—Operative Management of Endocrine Dysfunction. James D. Hardy, M.D., F.A.C.S. Philadelphia, W. B. Saunders Company, 1952. $5.00.

Surgery and the Endocrine System presents still another treatise on the fundamental mechanism whereby man survives injury and illness. Concise, interestingly written, bristling with fascinating subject material, this small book merits the careful attention of all surgeons. It provides useful information concerning fluid and electrolyte balance, nutrition, preoperative and postoperative care, and convalescence. It serves, therefore, as an excellent review of the ancillary care of the orthopaedic surgical patient and will be of great value to the surgeon.

Among the important problems dealt with is the metabolic interrelationship which exists between injury on the one hand and the endocrines, especially the adrenal cortex, on the other. The total eosinophil count is stressed as a useful tool in the surgeon's assay of the response of the patient to injury. The specific ways in which inadequate preoperative preparation and inadequate nutrition reduce surgical success, particularly in the aged, is especially illuminating. This is of importance to the orthopaedic surgeon, because he too is directly concerned with these same problems.

The total inadequacy of our knowledge of the processes which return our patients to the state of well-being from the atrophy of illness is stressed.

Academically, one may offer the criticism that the author does not stress sufficiently that the endocrine interrelationships are permissive rather than causative agents in the metabolic response to trauma. However, this problem is one which does not concern us on the clinical level, and does not detract from the book.

Finally, the bibliography which Dr. Hardy offers, is a listing of one of the finest collections of papers on the subject of the metabolic response to injury that is available today.

The book is highly recommended to all orthopaedic surgeons, and will provide not only useful information but provocative research ideas applicable to orthopaedic surgery.

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Acta Anaesthesiologica Belgica (Bruxelles), **4:** No. 1, 1953.
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Acta Chirurgica Belgica (Bruxelles), **52:** Nos. 4, 5, 6, 1953.
Acta Medicinae Okayama. Okayama University Medical School (Okayama, Japan), **8:** No. 2, 1952.
Anales de la Facultad de Ciencias Medicas Universidad Nacional de Asunción (Asunción, Paraguay), **8:** No. 25, 1950; **9:** No. 26, 1951.
Anales del Servicio de Traumatología del Dr. Lopez-Trigo (Valencia), **7:** Núm. 4, 1952; **8:** Núm. 1, 1953.
Archiv für Japanische Chirurgie (Kyoto, Japan), **21.** Band, 1. Heft, 1952; **22.** Band, 1., 2., 3., und 4. Heft, 1953.
Archiva Medica Belgica (Bruxelles), **8:** Fasc. 1, 2, 3, 1953.
Archivos de la Sociedad de Cirujanos de Chile. XXV Congreso Chileno de Cirugía. 21 al 24 de Noviembre de 1952, Santiago de Chile.
Archivos de la Sociedad de Cirujanos de Chile (Santiago de Chile), **5:** Num. 2, 1953.
Asistencia Social (Merida, Yucatan), **3:** Num. 10, 1953.
Atti del XXXVI Congresso della Società Italiana di Ortopedia e Traumatologia. Roma, 20–21–22 ottobre 1951.
Boletin del Hospital Militar (Habana), **5:** Num. 4, 1952; **6:** Num. 1, 1953.
Boletín del Instituto de Patología Médica (Madrid), **8:** Núms. 5, 7, 8, 9, 1953.
Boletines de la Sociedad de Cirugía de Rosario (Rosario, Argentina), **21:** No. 7–8, 1952.
Boletines y Trabajos de la Sociedad Argentina de Ortopedia y Traumatologia (Buenos Aires), **18:** Nos. 2, 3, 4 y 5, 6, 7, 1953.
Bollettino Bibliografico (Milano), **3:** 5/6, 1953.
Cirugía, Ginecología y Urología (Madrid), **5:** Núms. 4–5, 6, 1953; **6:** Núms. 1, 3, 1953.
Cleveland Clinic Quarterly (Cleveland), **20:** Nos. 3, 4, 1953.
The Crippled Child (The National Society for Crippled Children and Adults, Inc., Chicago), **31:** Nos. 3, 4, 1953.
The Gunma Journal of Medical Sciences (Maebashi, Japan), **2:** Nos. 1, 2, 1953.
Harper Hospital Bulletin (Detroit), **11:** Nos. 3, 4, 5, 1953.
Journal of Asclepiion of Voula (Athens), **3:** No. 1, 1953.
The Journal of the Osaka City Medical Center (Osaka, Japan), **1:** Nos. 3, 4, 1952; **2:** No. 1, 1952.
The Keio Journal of Medicine (Tokyo), **1:** No. 4, 1952.
The Kumamoto Medical Journal (Kumamoto, Japan), **5:** No. 1, 1952; **5:** No. 2, 1953.
Kyushu Memoirs of Medical Sciences (Fukuoka, Japan), **3:** No. 2, 1952.
Médica (Matanzas, Cuba), **12:** Núms. 2, 3, 4, 1953.
The Medical Journal of Malaya (Singapore), **7:** Nos. 3, 4, 1953.
Medicina Practicá (Zaragoza), **9:** Núms. 86, 87, 88, 1953.
The Nagoya Journal of Medical Science (Nagoya, Japan), **15:** Nos. 3, 4, 1952.
Nagoya Medical Journal (Nagoya, Japan), **1:** Nos. 1, 2, 1953.
Old Farmer's Almanac (Dublin, New Hampshire), 1954.
Osaka Daigaku Igaku Zassi (Osaka, Japan), **5:** Nos. 5, 6, 1953.
Proteccion Social (La Paz), **15:** 175–176, 177–178, 1952.
The Red Cross World (Geneva), **34:** Nos. 2, 3, 1953.
Research Work Published in Sweden (Stockholm), Nos. 16, 17, 1953.
Revista del Colegio Médico (Habana), **4:** Num. 1, 1953.
Revista de Neurologia Clinica (Madrid), **1:** No. 1, 1953.
Revista degli Infortuni e delle Malattie Professionali. Numero Monografico Dedicato alla Chirurgia Traumatologica (Milano), 1953.
The Rockefeller Foundation. Annual Report. 1952.
Sanidad y Beneficencia Municipal (Habana), **12:** Num. 4, 1952; **13:** Num. 1, 1953.
Segundo Congreso Uruguayo de Cirugia (Montevideo), 1951.
Sociedad de Cirugia de Cordoba, Boletines y Trabajos (Cordoba, Argentina), **15:** Nros. 1, 2–3, 1953.
Student Medicine (Cornell University), **1:** No. 2, 1953.
Transactions of the American College of Cardiology. Vol. 2, 1952.
Unidia (Bogota), **1:** No. 3, 1953.
Villaclara Medica (Santa Clara, Cuba), **22:** Núm. 6, 1952.
Wakayama Medical Reports (Wakayama, Japan), **1:** No. 1, 1953.

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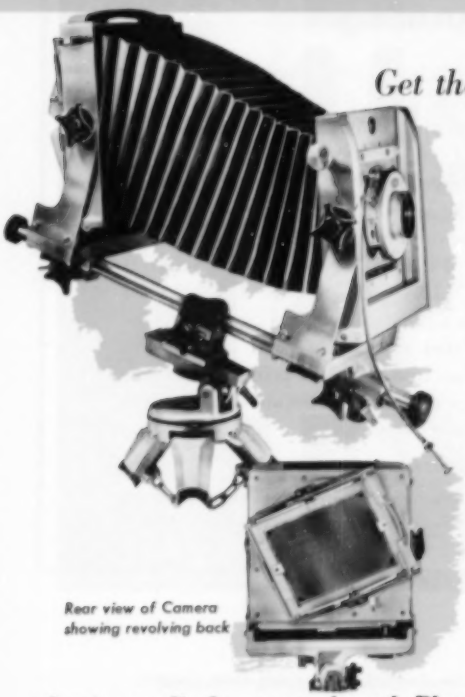

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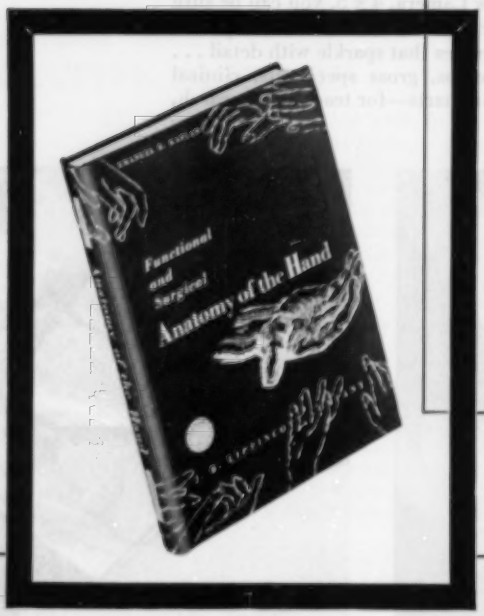

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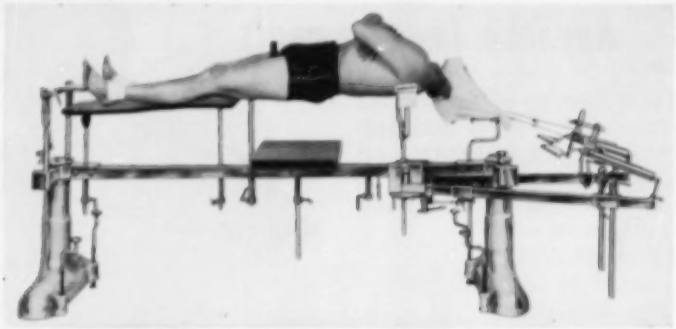

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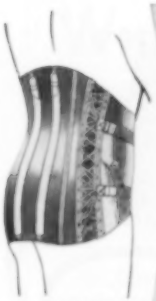

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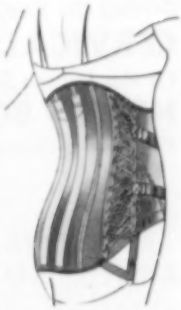

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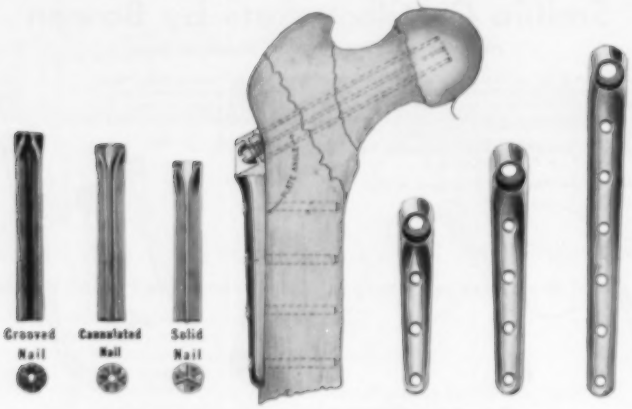

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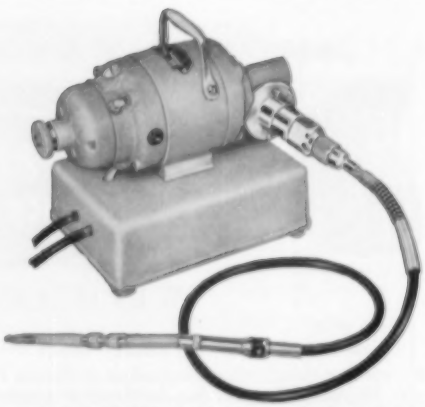

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